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SIR WILLIAM FOTHERGILL COOKE.

WILLIAM FOTHERGILL COOKE was born at Ealing, in the county of Middlesex, in the year 1806. His father, W. Cooke, was a doctor of medicine in Durham; and after a school education at that town he was sent to Edinburgh University to complete his studies. Like most of the famous electricians of that day, and even of our own day, he was not bred to the study of electrical science.

It was while engaged in a course of surgical training at Heidelberg that one day in March, 1836, he happened to witness an electrical experiment exhibited by Professor Moncke to his class, which greatly interested him, and planted the seed of inventive thought, which speedily grew into the first practical telegraph. The telegraph, like every other invention, including even the phonograph, was not entirely the work of any one man, but was led up to step by step by a number of different thinkers and experimenters. In 1820 Versted discovered the fact that a current circulating in a wire has power to deflect a magnetic needle freely poised in its neighborhood; and Gauss and Weber subsequently applied this fact in devising and erecting a short private line of telegraph between the physical cabinet of the University and the Observatory of Göttingen. It was a similar contrivance to this which Professor Moncke showed to his students on that day when Mr. W. F. Cooke was present. It consisted of a battery, a conducting circuit of wire extending from one room to another, and a pair of rude galvanometers or coils of wire encircling suspended magnets. With this elementary apparatus Professor Moncke succeeded in exchanging visible signals between the two rooms by means of the electric current. Probably no other student in the room but the young Englishman saw the immense practical importance of such an arrangement. This side of the experiment struck Mr. Cooke so forcibly, that from that day he gave himself entirely up to scheming and pondering over the subject, and within three weeks after he had devised a practical working telegraph on the basis of the Moncke, or rather the Gauss and Weber apparatus. The plan involved the use of six wires, forming three separate circuits, for as yet Steinheil's great discovery that the earth itself would act as a return wire was not known; and each circuit operated a separate needle galvanometer. The alphabet or code comprised 26 signals, and he employed three keys to make and break the circuit, together with a rudimentary switch to alter the connections from "send" to "receive," or contrarily. In 1836 he also designed a mechanical telegraph on the musical box principle, in which the current passing through an electro-magnet attracted an armature which released a detent, and thereby permitted a barrel, studded with projecting pins, to revolve until one of the pins came into contact with a tangential lever, which broke the circuit, leaving an indicating dial, with the proper signal letter or figure exposed.

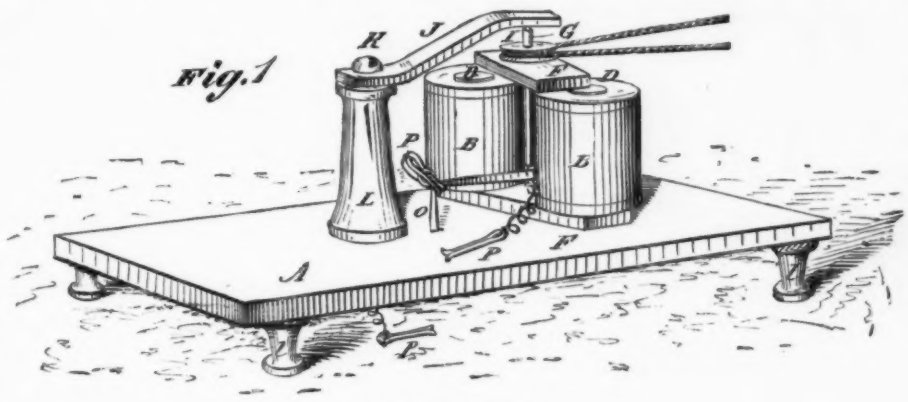
Cooke tried to get his new invention introduced on the Liverpool and Manchester Railway in the latter part of the same year, but the directors viewed the novelty with small favor, and condemned it as too complicated for their requirements, which was to transmit train signals along a tunnel. He therefore set himself to simplify his apparatus, and succeeded in doing so early in 1837, but by this time a pneumatic contrivance had been resorted to by the directors. Nothing daunted by this failure to get his schemes practically tested, Mr. Cooke continued to perfect his apparatus He engaged in experiments to ascertain at what distance an electric current would excite temporary magnetism in the electro-magnet employed to move the detent of his mechanical telegraph; and consulted Faraday, Dr. Royet, and Professor Wheatstone on the point. It was on the 27th of February, 1837, that he first met Wheatstone, who had before that time been engaged in researches into the velocity of electric waves in solid conductors.

Cooke recognized that Wheatstone's knowledge and genius would be serviceable to him, and early in May, 1837, they entered into a partnership together with Mr. J. L. Ricardo, M.P., combining their ideas in a patent dated June 12 of that year. This patent described an improved form of Cooke's original invention, with five vertical galvanometer coils and astatic needles instead of horizontal ones, and having a diamond-shaped vertical face on which the five needles were pivoted, so that their relative positions could be seen at a glance. There were five separate circuits corresponding to the five needles, with one return wire common to them all. These five circuits were operated by five keys, and each signal was indicated by the relative motions of any two out of the five needles. This apparatus, since known as the "five-needle instrument," was first tried on the London and Birmingham and Great Western Railways, but was found expensive on account of the number of wires used, and subsequently abandoned. Nevertheless the "five-needle instrument," working in 1838–9, between the Paddington and West Drayton stations of the Great Western Railway, a distance of about 13 miles, was the first public telegraph in the United Kingdom, if not in the world. The original Paddington instrument now forms the chief relic of the Postal Telegraph Historical Department, and it is still to be seen on the occasion of every telegraphic fête of importance in London.

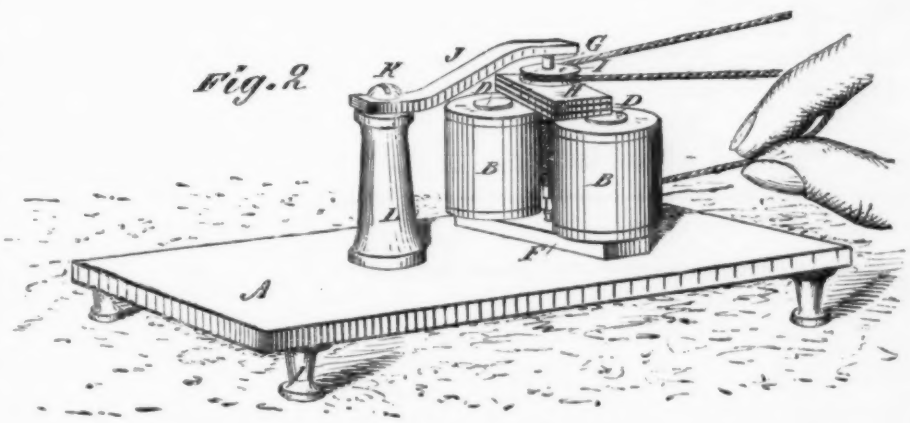
In the year 1840 Cooke established the Cooke & Wheatstone system on the Blackwall Railway, and in 1841 on a short line through the tunnel between the Queen Station at Glasgow and the engine house at Cowlairs Junction on the Edinburgh and Glasgow Railway. The following year the telegraph line from Paddington to West Drayton was continued to Slough near Windsor, and a great public interest in it was soon after excited by the clever capture of a Quaker named Tawell, who had committed a daring murder near Slough, and escaped by rail to Paddington, where, thanks to the original five-needle instrument, two detectives were waiting for him as the train drew up to the platform. In 1843 two more short lines were erected, one in Ireland and one in England, and worked by the Cooke and Wheatstone apparatus. In 1844 a line of considerable length, from London to Portsmouth, was also opened for traffic on this system.

Mr. Cooke was rewarded for his great public services in establishing the telegraph by receiving the fourth Albert gold medal in 1863, his name being preceded on the list of recipients by that of the immortal Faraday; and on November 11, 1869, Her Majesty conferred upon him the order of knighthood in recognition of his great and special services in connection with the practical introduction of the electric telegraph. In 1871 he was granted a civil list pension of £100 per annum.

The last two years of his long and prominent career were spent in great privacy until his death, on June 25, at Farnham, in the seventy-third year of his age, after he had lived to see the inventions which his sagacity forced upon civilization develop extraordinary powers and gradually spread itself over the whole world.—*Engineering.*



ELECTRIC ENGINE.



MAGNETO MACHINE.

APPARATUS MADE FROM PARTS OF THE ELECTRICAL CABINET.

AN ELECTRICAL CABINET.

By GEO. M. HOPKINS.

THE number of persons who are interested in electrical matters at the present time is enormous, owing to the impetus given to the electrical science by the invention of the telephone and the recent improvements in electric lighting. Many amateurs have taken up the subject as a pleasant field for experiment and study, with a prospect of a possible reward for the discovery of a really practical novelty.

To assist this class of experimenters, especially the younger ones, I have devised what I will call an electrical cabinet, containing a few parts which may be combined to form several different pieces of apparatus, and which, with slight additions, may be employed in performing a great variety of experiments.

The first engraving shows in detail, full size, the several pieces required. There should be two bed pieces, A, with holes exactly as they are shown in the drawing, and provided with legs, *l*, which are the ordinary black carriage curtain knobs, to be had for a penny or so at any hardware store.

The following articles, which may be easily made, will be required: Two helixes, B, which consist of a thin wooden spool wound with 8 layers of No. 20 silk-covered copper wire. Two helixes, C, wound with about ¾ oz. of No. 34 silk-covered copper wire. Two soft iron cores, D, ⅜ in. diameter, a little longer than the helix, B, and having a threaded stem, *m*, of sufficient length to reach through the bed piece, A, and receive the nuts, E, two of the latter being required. The yoke, F, of soft iron, is drilled to receive the stems, *m*, of the cores, D, and having a small conical hole, *n*, in the center F' is a soft iron armature, having a central aperture, *o*, for receiving the spindle, G. A compound bar magnet, H, is also fitted to the mandrel, G. The milled nut, I, which binds the armature, F', or the magnet, H, upon the spindle is grooved around its periphery for receiving a cord or belt. The mandrel, G, has a small hole bored through it near the shoulder, and is flattened at *p* by filing on diametrically opposite sides so as to remove a little more than a quarter of the circumference on each side. J is a curved piece of brass, having a small conical hole, *q*, drilled in it for receiving the upper end of the spindle, G. It has also a hole through the opposite end for receiving the bolt, K. The pillars, L, of brass or wood are drilled longitudinally to receive the bolt, K. The latter is provided with a nut, N. The spring, O, is bent into the form represented and flattened at both ends. Twelve or fourteen wire loops, P, and two wires, Q, bent into the form shown, and threaded at the lower end, are required. R is a vibrator consisting of a small armature, *r*, soldered to a spring, *s*, which is drilled to receive the bolt, K. A small hole is drilled in the end of the armature to receive the wire of the bell hammer, S. U is a strip of brass bent into the shape shown, and having near one end a small hole, *t*, for receiving a screw For the sake of convenience I have placed above each cut a figure representing the number of pieces of each required.

With these simple parts, which may be made without further description, a great variety of experiments may be tried.

Simplest among the pieces of apparatus that may be made is the sounder, shown in Fig. 3. There is material in the cabinet sufficient for two instruments.

The pillar, L, is placed over the hole, *a*, and the spring, R, is secured to it by means of the bolt, K. The stem, *m*, of the magnet core, D, is secured in the hole, *b*, and the helix, B, placed on the core. The wire, Q, is screwed into the hole, *d*, so that the end touches the top of the spring, R, while the armature, *r*, is a short distance from the core, D. The key, U, is fastened to the bed by a small screw passing through the hole, *t*, into the hole, *h*, in the bed. Under the key a round-headed screw is placed in the hole, *g*, forming a contact point for the key. This screw is connected with the brass clip, *u*, by a wire. One terminal of the coil, B, is connected with the key, U, the other with another similar instrument. The clip, *u*, is connected with the battery,* the ground, or the return wire.

When these instruments are used on a closed circuit, the

* A suitable battery for this apparatus may be found among those described in SUPPLEMENTS 157, 158, and 159. Perhaps the Tom Thumb will answer as well as any home made battery.

key, U, is slipped laterally under the clip, *u*, after the signal to close the circuit.

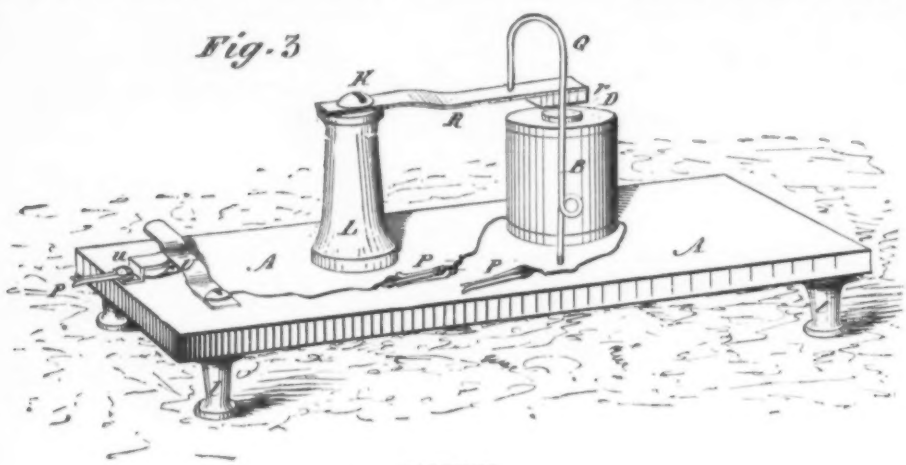
In the call bell shown in Fig. 4 the parts, L, R, D, B, Q, U, are arranged exactly as in Fig. 3. The bell, T, is secured to the base by a screw entering the hole, *f*, and the hammer, S, is inserted in the armature, *r*, so that it may strike the edge of the bell. One terminal of the coil, B, is connected with the wire, Q, the other with the key, U.

used for interrupting the current for an induction coil. By connecting wires and handles with the bolt, K, and the clip, *u* (the other connections remaining the same), the effects of the extra current may be felt.

The parts arranged as shown in Fig. 1 form a very pretty little electric engine.

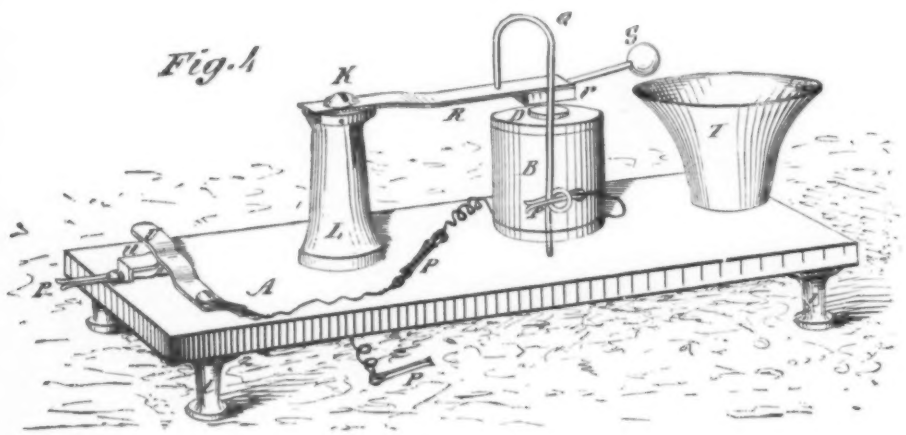
The stems, *m*, of the two cores, D, are inserted in the holes in the yoke, F, and secured in the holes, *c c*, by the arm of the spring, O, is inserted in the slit, *e*, in the bed, the longer arm touches the edges of the flat portion, *p*, of the spindle, G. The outer terminals of the coils, B, should be connected together to make a complete electro-magnet. The remaining wire of one of the coils is connected with the battery, that of the other coil is connected with the spring, O. The piece, J, is placed in communication with the battery either through the bolt, K, or otherwise. By carefully adjusting the spring, O, and arranging the flattened portion, *p*, to the best advantage, the armature may be made to revolve at a very high speed. It will of course be understood that the armature must run as near the face of the electro-magnet as possible without touching it.

Fig. 3



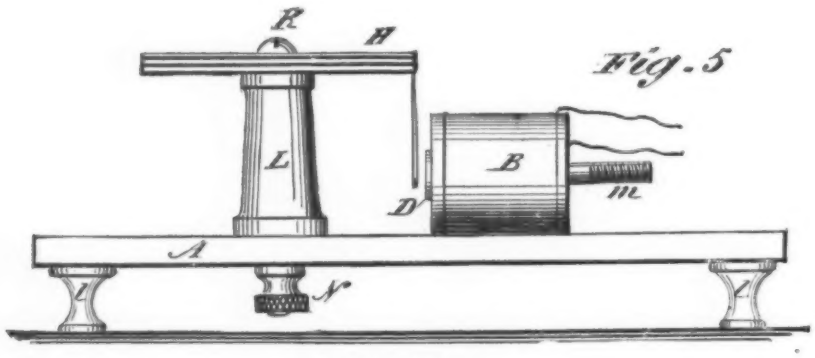
SOUNDER.

Fig. 4



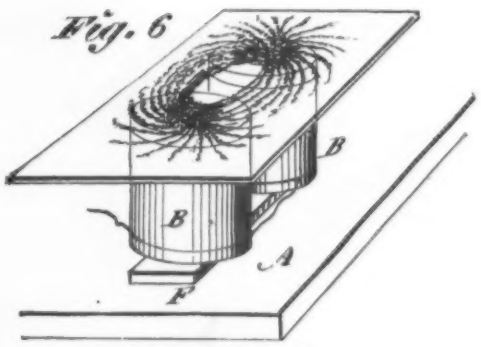
ELECTRIC BELL.

Fig. 5



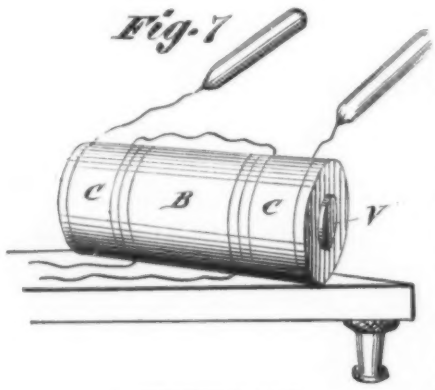
GALVANOMETER.

Fig. 6



MAGNETIC CURVES.

Fig. 7



INDUCTION COIL.

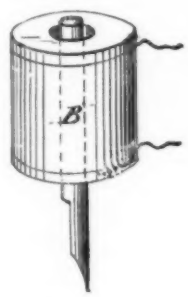
APPARATUS MADE FROM PARTS OF THE ELECTRICAL CABINET.

One of the battery wires is connected with the bolt, K, the other with the clip, *u*. The spring, R, in this case, is a vibrator. It may be made to operate more perfectly if a small flat spring is soldered to it so as to form a contact for the wire, Q. On closing the key, U, the armature vibrates rapidly and rings the bell.

By removing the hammer, S, the arrangement may be

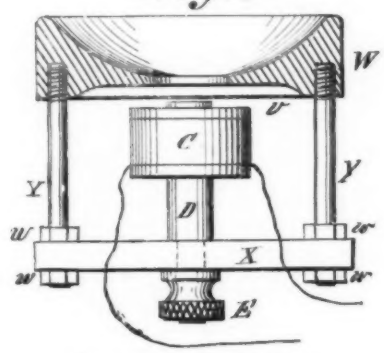
nuts, E. The armature, F, is placed on the spindle, G, and secured by the nut, I, so that the flattened portion, *p*, is at right angles with the armature. The lower end of the spindle rests in the conical hole, *n*, in the yoke, F; the upper end is received by the hole, *g*, in the piece, J, the latter being held in position by the pillar, L, and the bolt, K, which passes through the hole, *a*, in the bed, A. The shorter

Fig. 8



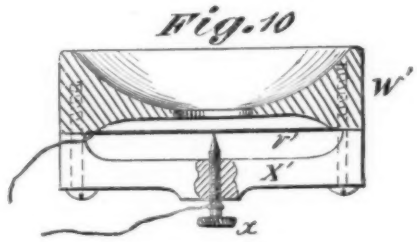
AXIAL MAGNET.

Fig. 9



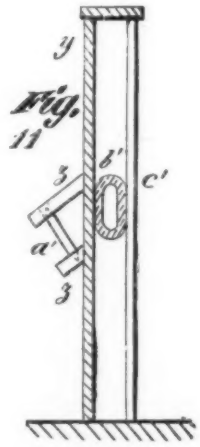
RECEIVING TELEPHONE.

Fig. 10



TRANSMITTING TELEPHONE.

Fig. 11



MICROPHONE.

APPARATUS MADE FROM PARTS OF THE ELECTRICAL CABINET.

Fig. 2 shows a magneto machine, in which the compound magnet, H, is substituted for the armature, F. The spindle is rotated in this instance, and the current is taken from the wires of the magnet. The magnet may be turned either by winding a string around the spindle as shown and pulling it off quickly as in whirling a top, or a small belt may be applied to the pulley, I. This machine simply serves to illustrate the principle of the magneto-electric machine. By substituting the coils, C, for the coils, B, the current may be more distinctly felt.

Fig. 5 represents a species of galvanometer that may be made by arranging the parts as clearly indicated in the engraving. A common cambric needle, suspended from the

magnet, H, in front of the core, D, will indicate the direction of the current.

In Fig. 6 is represented the method of forming magnetic curves. A piece of glass finely sprinkled with iron filings is placed on the poles of the magnet and jarred gently until the curves are formed.

Fig. 7 shows a method of illustrating induction. The two coils, C, and one of the coils, B, are arranged upon the long iron core, V. The coil, B, is placed in a battery circuit, with the parts shown in Fig. 4 arranged as a vibrator. The coils, C, are connected with each other and with the handles.

Fig. 8 shows the sustaining power of the helix. Fig. 9 represents a receiving telephone, and Fig. 10 a transmitting telephone for musical tones only. The diaphragm, V, in Fig. 9, consists of a piece of ferrotype plate. It is secured to the mouthpiece, W, by a cement compound of equal parts of pitch and gutta percha. The cross bar, X, is supported by two rods, Y, between nuts, *w*.

The core, D, is supported by the cross piece, X, and is adjusted to almost touch the diaphragm, V. Upon the core, D, is placed one of the coils, C. The mouthpiece and diaphragm of the transmitter shown in Fig. 10, are like those just described.

The cross piece, X', supports a platinum-pointed contact screw, *x*, which is adjusted so that it nearly touches a platinum disk soldered to the diaphragm. By placing the screw, *x*, in connection with one battery wire, and the diaphragm in connection with the other battery wire, and including the coil, C, in the circuit, tones made in the mouthpiece, W', may be heard in the mouthpiece, W. By substituting a permanent magnet about 5 inches long for the core, D, the instrument may be used in connection with another similar instrument, and articulate speech be readily transmitted. In fact it is then nothing more nor less than the Bell telephone.

The microphone shown in Fig. 11 may be used in connection with the telephone shown in Fig. 9. It consists of a pine box, *y*, having attached to its face two pieces, *z*, *z*, of battery carbon, having conical holes for receiving the pencil, *a'*, of the same material. A cross bar, *c'*, placed in the back of the box holds a short piece, *b'*, of rubber tubing against the side of the box. The carbons, *z*, *z*, are included in a battery circuit with the telephone shown in Fig. 9.

Figs. 12 and 13 show an arrangement of an electrical pendulum, Fig. 12 being its side view, and Fig. 13 a front view. The magnet, B, is placed below a pendulum, *e'*, carrying an armature. The pendulum rod, *f'*, carries a pin, *i'*, that engages the fork of the three-arm lever, *g*. This lever moves on a stationary pivot, and its horizontal arms are bent downward toward the mercury cups, *h*. The two mercury cups are connected with one end of the coil, B, the other end of the coil being connected with a battery which is also in communication with the pivot of the lever, *g'*. As the pendulum swings it makes and breaks the circuit at the proper time to keep up its motion. It is a simple matter to cut one of the wires and insert a magnet for operating the dial wheels of a clock.

THE NEW FORM OF LECLANCHE BATTERY.

By Dr. H. TOBLER, Professor of the Zurich Polytechnic School.

THE old form of Leclanché battery possessed, as is well known, a very considerable resistance, and the employment of a porous pot was subject to many inconveniences, which have prevented the greater employment of this description of battery. In the new and improved forms the inventor has dispensed with this porous vessel. The carbon electrode is surrounded with a mixture composed of 40 parts of pyrolusite, 155 parts of grain carbon, and 5 parts of resin, this latter substance acting as a cement. This composition is heated to 100° C., and subjected to a pressure of 300 atmospheres; it forms a homogeneous cylinder, in the axis of which is the carbon electrode. The inventor has given to this element the name of "conglomerate mixture" battery. These elements are extremely easy to manage; their electromotive force is higher than that of the old form, and their resistance less. Under the influence of the current, the peroxide of manganese is reduced to the sesquioxide, a body which is not an absolute conductor of electricity. The conglomerate will then offer a more or less high resistance. Moreover, it fills up the pores of the conglomerate with considerable quantities of ammonia, which tends to decompose it. When completely exhausted, it becomes a useless mass, which is only fit to be thrown away.

M. Leclanché has recently devised a new modification, which is made by attaching to the carbon depolarizing olates which can be renewed from time to time. The two or three plates are simply attached to the carbon by India-rubber rings.

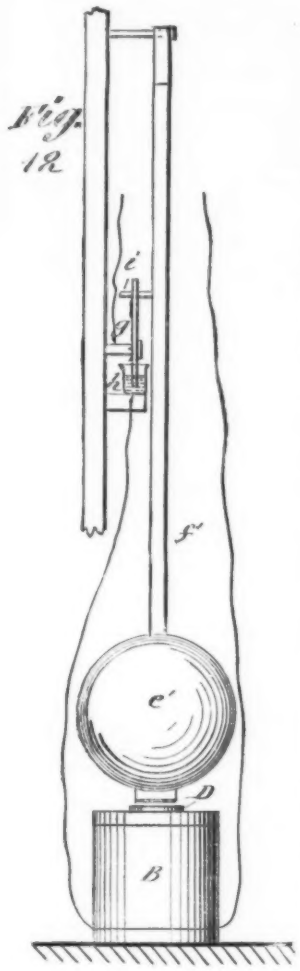
As regards the value of this new form of Leclanché battery, in the *Traité de la pile électrique* of Niaudet, the electromotive force is set down as 1·6 that of a Daniell, and as regards its resistance, M. Barbier states that it exceeds that of an iron wire 400 meters long and 4 millimeters in diameter.

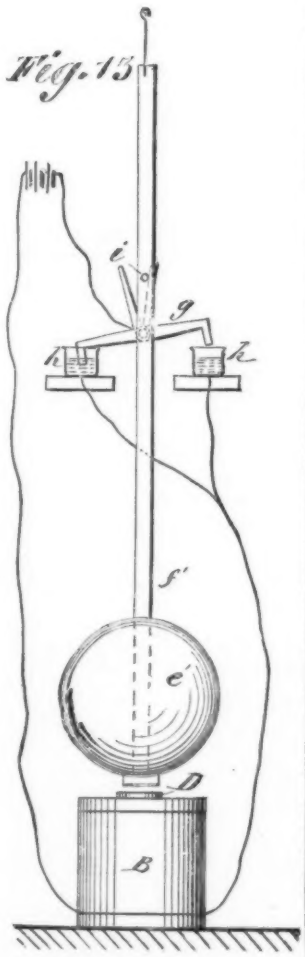
It is certain from these experiments that the electro-motive force diminishes rapidly when the resistance is low, but that it recovers rapidly when the battery is at rest. The Leclanché element will not answer, therefore, for all purposes: thus, for example, the battery could not be employed on a closed circuit, or where the circuit is often closed. In other cases it is a useful battery, on account of its high electromotive force and its low internal resistance.

PHYSICAL SOCIETY, LONDON, JUNE 28, 1879.

Prof. W. G. ADAMS in the Chair.

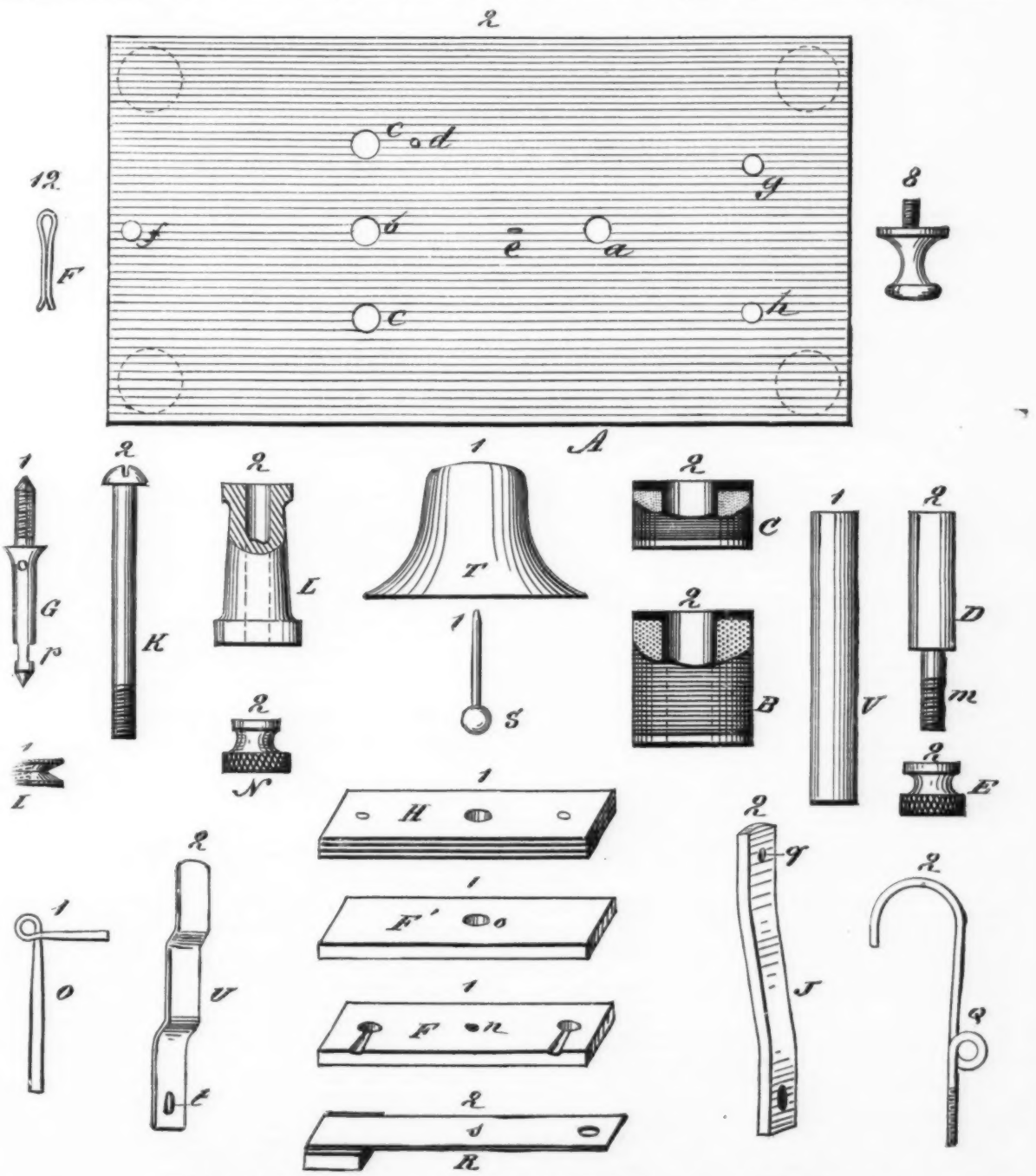
New Polariscope.—Prof. W. G. ADAMS, the President, exhibited his new measuring polariscope. It consists of three principal parts. The lowest section consists of a mirror, a lens, a Nicol's prism, and two other lenses. The upper section consists of lenses and Nicol's prism arranged in the reverse order. Each lens and Nicol's prism is supported separately by screws, and its position can be altered independently of the others. These two parts form a complete polariscope. Besides these there is a middle piece, consisting of two lenses (nearly hemispheres), forming a box to inclose the crystal immersed in oil, their curved surfaces being concentric. The whole middle piece is supported on the tubes of the upper and lower portions, and may be turned





ELECTRICAL PENDULUM.

APPARATUS MADE FROM PARTS OF THE ELECTRICAL CABINET.



SEPARATE PARTS OF THE ELECTRICAL CABINET.

about the optical axis of the instrument. The vertical graduated circle carrying the central lenses and crystal may be turned through any angle about its horizontal axis. By means of an arc fastened perpendicularly on the graduated circle, with its center at the center of curvature of the central lenses, the crystal may be turned about another horizontal axis at right angles to the former, so that the crystal and the central lenses can be turned about each by three axes which are mutually at right angles. By means of a system of toothed wheels in gear with the rims of the central lenses, the crystal and central lenses may be turned separately about the optical axis of the instrument, so as to bring the planes of the optic axes of a biaxial crystal parallel to the plane of the vertical graduated circle.

On the Distribution of Heat in the Spectrum.—Sir JOHN CONROY, Bart., read a paper. After referring to Dr. J. W. Draper's supposition that all the rays in the spectrum have the same heating effect, and to his statement that, owing to the unequal dispersion of the prism for rays of different refrangibility, the method that has been usual for determining the calorific intensity of the various parts of the spectrum is an essentially defective one, the author described a graphical method for eliminating the effect of the unequal dispersion of the prisms, and showed that from MM. Fizeau and Foucault's measurements, and also from those of Lamansky and Prof. Tyndall, the maximum intensity is about the middle of the visible spectrum and not at the red end; and, further, that the curves given by various observers as representing the intensity of the heat in different portions of the spectrum are, in reality, the "dispersion curves" for the particular prisms employed.

On the Measurement of the so-called Thermo-Spectrum.—Captain ABNEY, R.E., called attention to his published paper, wherein he shows that the distribution of heat in the spectrum is a misnomer, and that what was really measured by Lamansky and Tyndall was the energy absorbed by the lampblack and the absorption due to the prisms used. He considered that there was no inherent heat in the spectrum. He found that Dr. Draper had not taken into account the amplitude.

Prof. GUTHRIE said that Captain Abney had expressed what many thought, namely, that heat was radiant energy.

Electrical Induction.—Mr. GRANT then described an investigation which he had made into the induction lines round two parallel coils of wire: in the primary coil, an intermittent current of electricity from a Leclanché battery flowed; and in the secondary, a telephone was connected up to detect the induction sounds. With this apparatus he found that with the coils kept parallel to each other, there were lines, or rather a surface of minimum induction, surrounding the primary, and that if the secondary were placed in these lines hardly any induction noise could be detected. A diagram, representing a medial section through the coils, showed the lines to proceed from the wire of the coils in two curves resembling parabolas, one from each cross section of the wire outwards.

Lines of Magnetic Force.—Dr SHUTTLE then described his experiments proving the lines of force in a bar magnet to run spirally round the bar between the equator and poles, the equator being decentered and oblique across the bar, as shown by diagrams.

The New Theory of Terrestrial Magnetism.—Prof. ROWLAND, of Baltimore, made some observations on the new theory of terrestrial magnetism of Profs. Ayrton and Perry. He said the experiments on which the theory was founded had been attributed to Helmholtz, but they were entirely his own, he having gone to Berlin to make them. The new theory had occurred to himself on making these experiments, but he had rejected it because he found that the potential which the earth's surface would require to have would not only cause violent planetary disturbances, but by mutual repulsion drive objects off the earth. He had made also an experiment to see if absolute motion of electricity would cause magnetization, but failed to get any effect from it. Then he resorted to calculation to find the magnetic effect of relative motion by rotation of a charged sphere of perfect magnetic permeability that is more magnetic than iron. He found that when the sphere was uniformly charged and rotating there would be a magnetic field in its interior; but, instead of the result of Messrs. Ayrton and Perry, that if the earth were charged to a potential of, he believed, 10^8 volts relatively to interplanetary space, the earth's magnetism would be what it is, he found the necessary charge to be $61 + 10^{15}$ volts. In the ordinary atmosphere this potential would produce a spark nine million miles long, and discharge across to the moon. If the moon were electrified to the same degree, the mutual repulsion would overcome the force of gravity between them. He therefore considered terrestrial magnetism to be still a mystery. He had also thought that the aurora borealis might be explained by supposing the upper regions of the earth's atmosphere electrified. The winds carrying the upper strata towards the poles, electricity would condense there. This hypothesis is tenable still.

Prof. AYRTON said that whether or not the new theory of magnetism should be so rejected depended on whether or not Prof. Rowland's calculations, or those of himself and Prof. Perry, were wrong. It has been found by Sir William Thomson, from experiments at Arran, that the earth was electrified with respect to the air, and that there is a difference of potential of 30 volts between earth and air for each foot of ascent. This gave 1360×10^{23} centimeter-gramme second electrostatic units as the potential of the earth. The new theory required the potential to be 1011×10^{11}, or supposing the earth to be solid iron, about 14 times more, a wide margin.

Prof. ROWLAND said he had not seen the calculations of Profs. Ayrton and Perry yet; but he believed his results to be correct, as he had checked them in various ways.

Rotation of Copper by Magnets.—Mr. BAILLEY exhibited a modification of Arago's experiment, in which a copper disk is caused to rotate continuously by changing the polarity of four electro-magnets underneath by a revolving commutator.

Internal Current of Battery.—Mr. CONRAD COOKE exhibited a single voltaic element showing the internal current. This is done by forming the glass vessel containing the element into a helical tube between the poles, and hanging a galvanometer needle in the interior of the helix; the internal current deflects the needle.

PROF. RICHARDSON considers absinthe drinking worse than opium eating. In the worst examples, the absinthe drinker becomes a confirmed epileptic. One or two wineglassfuls of it a day will produce permanent dyspepsia. "A more consummate devil of destruction could not be concocted."

NEW FRENCH TORPEDO BOATS.

THE construction of a certain number of torpedo boats, capable of very high speed, was some time since confided by the French government to the "Société des Forges et Chantiers," de la Méditerranée, to M. Normand, of Havre, and to MM. Claparède et Cie., of St. Denis (Seine). The results obtained by these firms are stated to have surpassed all previous achievements of the same kind, including the remarkable vessels constructed in England by Mr. Thornycroft about two years ago. The great speed of these boats is the result of their pointed shape, their comparative lightness, their diminished draught, the increased diameter of the propeller, the axis of which is placed close to the keel, and lastly, and especially, their high propelling power, combined with small weight and bulk, which is attained by means of the most perfect arrangement of engines and boilers.

The torpedo boats which have been furnished to the French navy by MM. Claparède, and which recently underwent official trials at Cherbourg, have given the results detailed below. These vessels have the following dimensions:

Length from stem to stern	89 feet 4 inches.
Breadth of floating-line	10 feet 10 inches.
Area of midship frame immersed when loaded	21·62 square feet.
Displacement when loaded	30·586 tons.

The hull is built of steel plates and angles. It has seven water-tight compartments, viz., one at each end, two in the forepart of the vessel, one of which is furnished with a watch-tower, one aft, having another watch-tower, the boiler-rooms, and the engine-room. The boiler, which is of the locomotive type, with a fire-box of copper and tubes of brass, has 516·48 square feet of heating surface. A ventilator, placed in the boiler-room (which is perfectly water-tight), and set in motion by a small special steam-engine, pumps into that compartment the air needed for combustion and for respiration by the stokers. The temperature of the engine and boiler rooms never exceeds 75° F. The pressure of the air produced by the ventilator, which makes as many as 1,100 revolutions per minute, can be made equal to raising a column of water to a height of 7·09 inches. Each square foot of the surface of the fire-grate is capable of consuming 500 lb. of coal.

The engines are compound, with three cylinders, all the working parts being of cast steel.

A steam rotary pump effects the circulation of the water through the surface condenser tubes, and the feed water, which is always uniform, is returned to the boiler by a feed-pump worked by the engine at half the speed of the latter. The air pump is also under the direct control of the engine.

During the official trial, lasting three hours, and in spite of the great amount of motive force developed, the engines performed admirably, no heating taking place, even to the smallest extent, nor was there any trace of strain observable.

The various maneuvers of starting, stopping, and change of direction are effected instantaneously, by means of a simple lever capable of being easily operated by a single man.

The following were the results of the official trials of the Claparède torpedo boats on the roadstead at Cherbourg:

Total displacement	30·586 tons.
Area of midship framing immersed	21·62 square feet.
Surface of displacement floating	632·58 "
Mean power of the engines during the three hours' trial	320 horse power.
Highest speed, at this trial, during one hour	19·925 knots.
Total heating-surface of boiler	516·48 square feet.
Pressure	127·6 lb. per square inch.

It should be observed that the speed required by the naval department was 18 knots, and that the Thornycroft torpedo boats, with a displacement and a considerably less immersed keel than those of the Claparède vessels, did not exceed 18½ knots per hour. It is unnecessary to remark how great an advantage this increase in speed of 1½ knot gives to the new French torpedo boats.

M. Normand, of Havre, like Mr. Thornycroft, has adopted a two-cylinder engine. The results which he has obtained, although superior to those of the English constructor, give inferior figures to those quoted above; notwithstanding that M. Normand had adopted for his boilers a heating surface 1½ times as great as that of MM. Claparède. Lastly, by the employment of three cylinders, and by the perfect equilibrium of the working parts, the vibration which has been observed in all other torpedo boats is entirely avoided. In the construction of the engines, all the parts which are made of the finest materials obtainable, have been reduced to the minimum weight, without thereby diminishing their resistance, while the boiler, in spite of the comparatively large dimensions of its furnace, is light, and occupies only a small space.

In conclusion, it may be said that the Claparède torpedo boats are in every respect the most perfect models of this class of vessel that have yet been produced in any country. —*Universal Engineer*

RAILWAY BRAKE EXPERIMENTS.

A SERIES of experiments with the Westinghouse brake were lately commenced on the line of the North-Eastern Railway, England, between York and Starbeck, under the charge of Captain Douglas Galton, C.B., F.R.S., with a view of obtaining, by means of the most improved appliances, grounds for settling the question of the friction of rolling bodies. A train consisting of 16 carriages, including an experimental van lent by the Brighton Railway Company, was placed at Captain Galton's disposal. The train was fitted with the latest improvements in the Westinghouse brake. The weight of the whole train was 207 tons 19 cwt. 3 qrs., the weight on the braked wheels being 195 tons 7 cwt. 2 qrs. The experiments commenced at mid-day. The first set was made with a view of showing the power under the control of the engine driver of bringing a train to a stop, as in the ordinary working of the traffic, without inconvenience to the passengers. When going at a rate of about 40 miles an hour, the train was first brought to a stand-still near Poppleton Station, in some 400 yards. A second stoppage was effected at Marston Station, the train being brought up in about 280 yards, when going at a speed of about 45 miles an hour. These and the following experiments were made first with friction valves, and then without the valves. The second set of experiments were made on the same line for the purpose of testing the value of the friction valves when the engine driver has to stop the train suddenly, as in the case of a probable collision. On the return journey a speed of 50 miles was attained, when the brake was applied and the train brought to a standstill in about 200 yards. In the second trial the speed was 50 to 55 miles per hour, and a stoppage was brought about in 240 yards. A third experiment produced a stoppage in little over 200 yards, and a fourth trial was similarly successful. The third set of experiments were made to test the value of the friction valves, as in case of an accident breaking the train in two sections, by slipping a portion or the whole of the train from the engine. The first experiment consisted in detaching fifteen carriages by means of a slip coupling when the train was going at 50 miles an hour, the pressure in the reservoir being 50 lb. on the square inch. The result was, the detached portion came to a standstill in 240 yards. The second time, at 60 miles an hour and a pressure of 70 lb. on the inch, the stoppage was made in about 200 yards. In the third trial, at 60 miles an hour and 80 lb. pressure, the pulling up was accomplished in about 265 yards. The last three experiments were made practically on the level. The experimental van was fitted with machinery for indicating the speed of the train, the distance in which a train could be brought to rest, and the amount of strain on the drawbars of the carriages. The van was connected with the engine by means of an electric wire, through which the engine driver was signaled when the brakes were to be applied. The experiments were considered highly successful.

CASTING WHITE METAL AROUND AXLES.

FOR some time it was suspected by the officers of the Frankfurt-Bebra Railway that the practice of casting white metal bearings round steel axles had been the primary cause of several breakages, and the experiments were undertaken to ascertain the possibility of such being the case. From vol. lvi. of the "Proceedings" of the Institution of Civil Engineers, p. 321, we learn that, by repeating the casting process a number of times on the same axle, it was found that in every case, and with every kind of steel tried, cracks appeared sooner or later, sometimes on the second trial, sometimes not till the forty-fifth. The white metal used contained 7 parts copper, 14 parts antimony, and 79 parts zinc, and melted between 450° and 500° C., 810° to 932 Fah. These experiments tend to show that the common plan of casting white metal round the axle is a fruitful source of danger.

FRICTION.

FROM a number of experiments on railway axle friction, made some years ago, it was concluded that (1) the friction increases with the load, and in a considerably higher ratio; (2) that the friction increases with the velocity, but not in the same proportion as with the load; (3) that gun metal bearings have been found to produce the least friction, but that they require more careful fitting.

Various iron and cast steel axles were employed for the experiments, all having been in use for some time. The journals of the iron axles were 3·15 in. diameter by 5·6 in. length. Those of the cast steel axles were 2·8 in. by 5·6 in. The speed was 180 and 360 revolutions per minute. The loads were 321, 631, 941, and 1,251 lb. per journal. One gun metal, one tin, and one lead alloy were used for the brasses. The inferences drawn from those experiments were as follows:

(1) The coefficient of friction for iron and cast steel axles, when lubricated with rape oil or colza oil, and with bearing of tin alloys or hard lead, is between 0·009 and 0·0099.

(2) For the same axles, with gun metal bearings, the coefficient is 0·0141.

(3) The coefficient of friction, for such loads as occur on railway vehicles, is independent of the load, consequently a smaller or larger bearing surface of the journals is (within certain limits) of no influence on the friction.

(4) The coefficient of friction, for such velocities as occur in railway vehicles, is independent of the velocity.

(5) When grease is used as the lubricant, the coefficient of friction is greater than with oil for small loads, but for heavier loads, where the journals become warm more quickly, the coefficient of friction is the same for grease and oil, except at starting.

Different sets of experiments have given different results. By some experiments, made on the London and Southwestern Railway, to determine the resistance with oil as compared with grease, axle boxes and carriages weighing about 6 tons 4 cwt., the tractive force, in pounds per ton weight, required to keep them in motion was as follows: for seven different experiments, 2·8, 2·6, 2·9, 2·2, 4·0, 2·6, giving a mean of 2·85 (Proc. I. C. E., vol. xxviii.).

The bearings were of white metal, and the loads small, both of which circumstances would tend to diminish the resistance. This average gives a coefficient of 0·0127 for oil axle boxes with white metal bearings. More recent experiments have given, it is said, still lower results for oil, so that, on the whole, we may safely assume that the coefficient of friction for gun metal bearings, well lubricated with oil, is 0·014, and for white metal bearings, 0·012.

COMBUSTION OF COAL IN BOILER FURNACES.

IN a recent address delivered by William M. Barr, M.E., before the Indiana Millers' Association at Indianapolis, which we find in the *Miller and Millwright*, he says:

In designing a furnace it is important to know what kind of fuel is to be used. The fuels at our immediate command are wood, bituminous and anthracite coals. I think it improbable that any mill in Indiana is regularly using anthracite coal as a fuel. A small percentage of mills use wood, but the larger number use bituminous coal. Fortunately, we have not only an abundant supply but an excellent quality of bituminous coal in this State. The problem of the furnace is somewhat complex, as its functions are partly mechanical and partly chemical. A fair consideration of either of these would occupy too much time this evening, yet the importance of the subject will not allow it to be passed by without a word. The design of the steam engine as a whole is simply a train of mechanism by which fuel is converted into power in motion. For the present, then, we shall leave the steam engine and devote a few minutes to coal.

The best varieties of Indiana coal contain about 55 per cent. of carbon and 35 per cent. of hydrocarbon gas. The value of any fuel depends upon its capacity for giving off heat. In this respect the Indiana coals are entitled to take high rank when properly burned. Engineers usually estimate the value of coal by comparative evaporation. I do not think this is as good a way as that employed by chemists, who fix its value accordingly as it contains a greater or less number of heat units. By a heat unit is meant that

quantity of heat which will raise the temperature of water one degree Fahrenheit from 39° to 40°. This particular temperature is named because it is that at which water is at its greatest density. One pound of pure carbon, such as charcoal or good coke, yields about 14,500 such units when properly burned. One pound of hydrogen burned in oxygen gas, gives off during its complete combustion more than 60,000 heat units, or more than four times that of carbon. The thermal power of Indiana coal will not vary much from a general average of about 14,000 heat units; as this is not far below the theoretical value of carbon, and as our coal contains only about 50 per cent. of carbon, this number of heat units is to be accounted for by the presence of the hydrogen in the coal.

In burning this coal, the products of combustion of the carbon will be carbonic acid gas if perfectly burned; and carbonic oxide gas if imperfectly burned; of the hydrogen the product of combustion will be water.

A great deal has been said and written on the subject of smoke, and it has been made to bear the burden of incompetency these long years. I admit that smoke is a great nuisance, and should not be permitted to escape, especially in the larger cities and towns. Its prevention is not difficult, and in England, where its escape had become an unbearable nuisance, legislation was invoked, when a reconstruction of furnaces began, which soon solved the practicability of the problem. There is, of course, some loss attending a smoky furnace, but the loss by these sooty particles is not so great as is generally supposed. The great source of loss is by imperfect combustion, that is, by burning coal to carbonic oxide gas, instead of carbonic acid gas. Let us see what this amounts to. One pound of carbon is equivalent, as I stated a few minutes ago, to about 14,500 heat units when burned to carbonic acid gas; if burned to carbonic oxide gas its heating power is reduced to about 4,500 heat units—so you see that it makes a difference of about 10,000 heat units for every pound of carbon burned, whether it is burned to carbonic acid gas or carbonic oxide gas. This enormous waste may be going on constantly, without the knowledge of either the engineer or mill owner, for the reason that carbonic oxide gas is invisible. It would be a fortunate thing, indeed, if it were otherwise. The formation of this gas may be explained in some such way as this. Suppose the furnace to be in active operation, the grates covered with a mass of coal in process of combustion; the air entering the ash pit comes in contact with the body of highly heated carbon; the oxygen of the air unites with the carbon in the proportion of two atoms of oxygen to one atom of carbon to form carbonic acid gas. This is, so far, perfect combustion; but in passing through the body of the fuel it takes up another atom of carbon, which changes the chemical nature of the carbonic acid gas, and converts it into carbonic oxide gas, which consists of one atom each of carbon and oxygen. This product, unlike the first, is imperfect combustion. Now, if we have a properly constructed furnace we may again convert this carbonic oxide gas into carbonic acid gas. What is needed is a supply of air above the fire. The air must be admitted in limited quantity and at a high temperature. A very good way to get this is to build hollow walls around the furnace, and force the air past the highly heated fire brick lining. This ought to raise the temperature up to several hundred degrees.

Another source of loss is occasioned by the admission of too much air in the furnace. The actual quantity required is about 150 cubic feet per pound of coal; it has been experimentally determined that about double this quantity is usually supplied. In addition to this about one-fourth of the total heat of the furnace passes up the chimney, serving no other purpose than making a draught through the fire. Let me put this in another way: those of you who are burning four tons of coal in twenty-four hours are losing the useful effect of one ton of coal, receiving nothing in return but draught or circulation through the furnace; I have made no calculations in regard to it, but I venture the assertion that it would furnish power enough to run a dozen blowers large enough to supply all the air needed to consume properly the same amount of fuel.

COAL MINING AT MT DIABLO, CAL.

THE coal measures of Mt. Diablo are situated in a range of hills half way between the summit of the mountain and the San Joaquin River. This range is parallel to the San Joaquin, which is about five miles distant, and it is separated from Mt. Diablo by a deep valley. The altitude diminishes gradually from 1,700 feet in the western to 200 feet in the eastern part. The strata are tertiary, and are all elevated at an angle, probably by the mountain breaking through them. The general dip is to the north, being 32° in the western and 15° in the eastern part of the measures, which are about 12 miles long, as shown by the outcrop of the strike which runs in a general east and west direction. These strata are composed chiefly of heavy bedded sandstones, carbonaceous shales, clays, and coal seams.

The mine of the Black Diamond Co. is situated in the most westerly portion, where the dip is greatest. This region is deeply dissected by narrow parallel cañons, which run from the San Joaquin plains to the summit of this range of hills. The cañon in which this company's mine is situated opens into a sort of amphitheater, caused by the main cañon branching into three or four small ravines. Here are the hoisting works, coal bunkers, dumps, etc., while a few hundred yards down the creek is the town of Nortonville, in which most of the miners live.

Although there are four seams of coal in the Black Diamond Co.'s property, only two of these are workable. These are about 1,000 feet apart, horizontally. The upper or Clark vein is of an average thickness of 28 to 38 inches, not being interstratified by slate or clay, but is all good workable coal, except where crushed by the bending of the strata. The lower or Black Diamond vein has an average thickness of from four to six feet, but it is not such good coal as the Clark vein, and it is more expensive to work, the roof and the floor being composed of shale and clay.

Formerly these mines were worked by running in horizontal tunnels to the seams, but this was not profitable only to a limited depth, and this means of opening up is now entirely abandoned. In the case of a tunnel there is no outlay necessary for hoisting or pumping, as the mine drains naturally.

The next method of reaching the seam was by an inclined shaft or slope run in at right angles to the seam, and after striking it, a counter slope was sunk on the seam.

The incline now in use, and through which most of the coal has been hoisted, is called the Mt. Hope slope. It is situated at the head of the principal ravine, 797 feet above low water, and is sunk at an angle of 37° 15′, to the south, striking the Clark vein at a distance of 293 feet. At this level a gangway runs east and west on the seam, and on this, at a point 85 feet east at the foot of the Mt. Hope slope, is a counter slope sunk on the seam, and at present worked to a depth of over 700 feet.

The slope and counter slope are both double tracked, and strongly timbered every three or four feet.

The cars are hoisted by a round three quarter inch rope. This passes over a pulley three feet in diameter, and is then wound on a cylindrical drum six feet in diameter, the motion of which is regulated by a 12 foot fly wheel. The engine has a 14x30 inch cylinder, and hoists a car in about 30 seconds.

The counter slope is fitted with a similar plan for hoisting. Though the slope was much better than a tunnel and had a greater production, still it is much inferior to a vertical shaft for many reasons. The incline necessitates a greater handling of cars and causes a greater loss of power. Two separate hoisting engines are needed, and one of these is underground, while only one engine is necessary for a shaft, and that one is on the surface near the boilers. The only objection to a shaft is the great outlay necessary for machinery, etc., before any coal is produced. But by using double cages and increasing the speed the production can be enormously increased.

The Black Diamond shaft is situated about 620 feet northwest of the Mt. Hope slope, being 839 feet above water level. It has a rectangular shape, the dimensions being 22 feet 4 inches by 11 feet 10 inches from out to out. This is the most convenient form, there being no pressure sufficient to necessitate a round or square shaft. It is divided into three compartments. Two are for hoisting, and are six by nine feet inside. The third was designed for pumping, but is now used for ventilation, and contains a ladder which runs the whole depth. This shaft is very heavily timbered all the way down by one and a half foot Oregon pine, the section being placed about two feet apart, and is a fine piece of work, requiring very little repairing.

At regular distances down the shaft levels are run out to strike the seams. The distance between two levels measured on the seam is called a "lift." The lift is made as high as possible, because every level entails an additional expense; still the height is limited by the difficulty of transportation and ventilation. The average height of the lifts in this mine is from 300 to 350 feet, this variation being caused by the change of dip in the seams. At each station there is a difference of level of six feet between the levels running to the two seams, so that by one stoppage, a car from each seam could be run on the double cage.

In the case of the tunnel, a horse could be used to draw out the cars, and the horse power could even be used as a motor to draw the cars up the slope, but steam now entirely replaces these more primitive means. There is a great saving by using steam, as the surplus power can be utilized in pumping and carrying on many of the minor operations, such as surface transportation, running the screens, etc.

When the Black Diamond tunnel was sunk, a very extensive system of hoisting machinery was adopted. At the mouth of the shaft is a well-braced and substantial hoisting frame constructed of heavy pine timbers two feet square. This frame, is about 30 feet high, thus affording ample room for the cages to come above the surface without hitting the top. This frame consists of six principal uprights all slightly inclined and bound together by a firm rectangular frame or top in which the pulley wheels work. Two of these uprights, in the line of greatest pulling force, are much more inclined than the others so as to act as braces.

The pulley wheels, two in number, are the large wheels over which the cable passes. The diameter of these is five or six feet, and they are provided with guides to prevent the cable slipping off.

In the drums it is very important that the diameter be large, as a short bend is very destructive to iron rope. In Europe the average drum is 20 to 25 feet, while here it is no more than five or six feet in diameter.

There are two kinds of drums in use at these mines; the ordinary wooden cylindrical drum for round cables, and the spool or bobbin drum for flat cables. The latter is used at Black Diamond shaft.

There seem to be many advantages of the flat cable and bobbin over the round cable and cylindrical drum.

The flat cable winds upon itself, and thus by increasing the diameter at each winding prevents the acceleration of a descending cage, which if the shaft were deep, would necessitate a conical drum in case of a round rope.

The flat rope seems better than the round rope, as its diameter is less than that of round cable of equal strength; the flat rope can be mended easily, and lasts for two or three years.

Two bobbins are fixed on the same shaft, and thus the engine has to hoist the weight of the coal, as the cage and empty car balance an equal weight of the other cage. By this means the motion is always uniform.

The engine used at the Black Diamond shaft has two horizontal 24-inch cylinders with five-foot stroke, and the power is applied directly to the shaft, thus doing away with the fly-wheel.

The foundation of the drum and engines is of solid brick built from bed-rock.

The steam is supplied to the various engines by 10 large Cornish boilers so connected that any two may be repaired without causing the others to stop. This great number is necessary, because the only water available for use is mine water, and as this is very sulphurous, incrustations form very rapidly.

The steam pipes are packed in asbestos, but there is necessarily a great loss by condensation in pipes many hundred feet long.

The fuel used is the slack coal from the screenings, and many tons of this almost unsalable fuel are burned each day.

Whether the seam be reached by an incline or by a level the same system of opening out and working the coal is adopted. The system here in use differs from the ordinary one on account of the steep dip and the thinness of the seams. From the point where the level reaches the seam a gangway is drifted to the right and left on the seam; the dimensions of this gangway are determined by the thickness of the seam, the strength of the roof, and the requirements of transportation and ventilation. The average dimensions in these mines are 8 feet wide at the floor, 5 feet wide at the roof, and 5 feet from floor to roof.

By adopting this trapezoid form, the requisite width is obtained and the least support is removed from the roof. These gangways are given a grade of a few inches in a hundred feet. The floor consists of rolley-way and a rude channel on either side for drainage.

Faulting is a chief feature of this mine, and it causes great difficulty in drifting. Almost every case is that of a simple slip, in which the strata on the hanging wall have sunk. The direction of the gangway must then be changed until it again cuts the seam, and it must cut it in such a way that the foot wall of the seam is about four feet from the floor of the gangway, so that cars can be easily loaded from the shoots.

Every 20 feet along the gangways on the seam shoots four feet wide are run up the seam, only the thickness of the seam being worked out. Safety pillars of coal 20 feet square are left all along the upper part of the gangway. The face of the seam is thus worked by a system of irregular steps.

As the coal is detached from the mass, it is allowed to slide down the shoots on slides constructed of sections of old boiler iron, which are laid so as to overlap one another. Thus by the simple action of gravity the coal may be transported several hundred feet, and by opening the mouth of the shoot it may be loaded into cars in the gangway.

Pine and redwood are the only materials used for timbering. All timbers are cut outside and are numbered, so that they can be sent in and fitted without further trouble. The stations and levels being the most permanent, are strongly timbered with the heaviest timbers. The method of timbering the gangways is very simple, consisting of two uprights surmounted by a cap piece or crown. The uprights are inclined, so as to shorten the crown piece without losing space. The size of the timbers is eight feet long by eight by ten inches in cross-section. These timbers need continual repairing, some being replaced every two or three weeks. On an average the timbering is replaced every three months. The stopes are timbered with redwood pieces four by six inches.

The cars are of such a size that when loaded they can be easily handled by one man. The usual capacity is one ton of loose coal. They are made of heavy pine planks strongly banded with wrought iron. The internal dimensions are: Length, six and one-half feet; width, two feet two inches; height, in front, two feet five inches; height, in rear, two feet eleven inches. These cars run on ordinary strap rails, which are spiked on wooden stringers. The gauge is three feet. Trains of from five to six of these cars are drawn from the working parts of the mines to the shaft by single horses. The average distance is over one-third of a mile.

The cage is made of iron, and has two platforms six feet apart. Each platform is provided with tracks for the cars. The time of hoisting is one minute for 400 feet. At the top of the shaft is a light wooden railing, which is carried up by the cage, leaving the way clear for the cars to be run off. As a security against accidents, the cage is fitted with a safety fastening for the cable and a safety catch to prevent the cage falling to the bottom. A good deal has been written about safety catches, and many kinds have been suggested. Generally after an accident some such device has been adopted. After awhile the men, relying on the security of the invention, become careless and thus invite another casualty. Also from long disuse the apparatus may be out of working order, or, if constantly in use, it may become worn out when most needed. The safety catch adopted at this mine consists of two eccentric cog wheels, so arranged that if the cable is loosened a powerful spring forces these eccentrics to grip the sides of the guides. This seems to be very effective, and does not disturb the timbering or destroy the guides. The safety fastening of the cable is a device to prevent overwinding by unloosening the cable if the cage goes above a certain height.

When a loaded car arrives at the surface, it is rolled off, an impetus being given it by rolling an empty car against it. The car is switched on to its appropriate track according as it goes to the dumps or to the bunkers. The bunkers are situated about 500 feet from the mouth of the shaft. Between these places there is a double track, built on a trestle, having a slight grade toward the bunkers. Over this track runs a slack endless wire cable, one inch in diameter, and jointed at intervals of eight or ten feet, by swivel joints. On the back of each car is an iron plate with notches in it. As the car is pushed under this cable the joints catch in the notches and the car is drawn to the bunkers. This cable is kept in motion by a small, one foot stroke engine, which turns a patent grip pulley about four feet in diameter. The average time of a car, from arriving at the surface to dumping, is about three minutes. Thus, in the entire operation, the coal is brought from the face of the seam to the bunkers without being transferred from one car to another.

The dumping is performed by an ingenious automatic-dumping platform. The forward end of the car is a door, which is suspended from the top by a rod acting as a hinge. This door is secured by a latch. The car runs on a small platform about four feet long, on which a track is laid, the ends of which are curved up to fit the wheel of the car. This platform is hung on side trunnions two feet above the rails, and by the impetus of the loaded car and the shifting of the center of gravity, the whole platform tips forward. There is a piece of curved iron so arranged that it will strike under the latch, and thus throw open the door, allowing the coal to dump on the screens below.

There are two of these dumping platforms, supplying two sets of screens, which are given a "jigging" motion by the small engine that runs the surface cable. The coal is picked and sorted by men and boys, who break the larger lumps by small picks and sledges, and cast the "bone" aside. The screens are at an angle of about 33°, and separate the coal into two grades. The marketable coal passes into bunkers, which hold about 1,600 tons. The coal is carried to the river by trains of coal cars made of sheet iron, and carrying about four and a half tons each. They are dumped at the wharf by a dumping platform similar to the above, but worked by machinery. The cars descend by the action of gravity, and are drawn back by a small engine.

Good ventilation is of more importance in coal mines than in any others on account of the danger, not only of impure air, but also of highly explosive gases. There are many causes of impure air, such as high temperature, breathing of men, burning of lamps, and slow combustion of coal and sulphur, decomposition of wood and accumulation of gases from the coal. Blasting is now done away with, except in safe places. The Davy lamp is used to test all places in which the gas may have formed. Sulphurous acid and sulphydric gas are very abundant in some parts of this mine.

The mines are admirably located for good ventilation. Several different devices have been used to cause artificial ventilation, but the one which seems most successful is the one now in use. There is a large fan wheel at the mouth of the shaft. This wheel is 24 feet in diameter, the fans being 5 feet wide. It is run at a moderate speed by a 3 foot stroke engine. This fan wheel draws the air out of the mine by a separate compartment. About two-thirds of the air goes down the hoisting compartments, and the remainder through an old ventilating shaft. By means of a system of canvas and wooden doors in the main gangways, the air is made to traverse the smaller workings where it is most

needed. There seems to be ample ventilation even in the remote portions.

These mines are also well situated for drainage, as the water naturally accumulates in the lower levels. The water is forced from each level to the level above by a double system of force pumps. The volume pumped out daily is immense, and does not vary much with the seasons.

The miners use small portable oil lamps which can be hooked on the cap. Each one supplies his own oil.

The losses in this mine are very slight, and are more the result of mechanical crumbling of the coal, which forms unsalable fuel; very little coal is left standing in the mine.

The Mt. Diablo mines have produced, up to 1877, about 1,875,000 tons of coal.

The Black Diamond mine is under the management of Mr. M. Morgans, and it is due to his kindness that I have been able to obtain the above facts.—*J. O'Callaghan, in Mining and Scientific Press.*

TRIANGULAR BLAST-HOLES.

To effect this the boring bar or jumper is partly turned on each side of its cutting alternately. No difficulty is experienced in boring the holes to this shape, and they are found more effective than round holes—the corners forming points at which the fracture of the material operated on appears to commence, the line of fracture usually forming a prolongation of the sides of the triangle.

AERIAL NAVIGATION.*

By F. W. BREAREY, Honorary Secretary to the Aeronautical Society, London.

ARTIFICIAL FLIGHT.

IN the paper which I read before the Aeronautical Society at the general meeting in 1878, I stated that, with respect to those of my models which are actuated by wing-movement, I had found a difficulty of sustaining the weight which appertains to the living example. But from experiments which I have lately made I find that the weight to be sustained depends upon power and strength of material employed, and also upon the right application of that power. For instance, in the wing-action of the bird, that portion of the pectoral muscle which depresses the wing is considerably more powerful than that which elevates it, because its function is to sustain the whole weight of the bird by impact upon the air. In my models I attain that action by affixing India-rubber cord, more or less in tension (according to the power used), underneath the wings, so that when the wings are elevated there shall be a strong downward impetus. There is, however, a disadvantage not shared by the bird—the upward stroke in the model absorbs much power in working against the tension of the India-rubber underneath. Given that power, and with material to endure the pressure, considerable weight can no doubt be sustained. What immediately concerns us, however, is this: Can the weight equal to that of a man and the additional power necessary to propel him be sustained by any material which man can construct light enough and strong enough?

Mr. Wenham, in his paper read at the first meeting of the Aeronautical Society, says: "Having remarked how thin a stratum of air is displaced beneath the wings of a bird in rapid flight, it follows that, in order to obtain the necessary *length* of plane for supporting heavy weights, the surfaces may be superposed, or placed in parallel rows, with an interval between them. A dozen pelicans may fly one above the other without material impediment, as if framed together; and it is thus shown how two hundredweight may be supported in a transverse distance of only 10 feet." But I think that the difficulty of actuating the wings of these twelve mechanically imitated pelicans would present as great a difficulty as the vibration and construction of wings of the dimension of "60 feet from end to end, and 4 feet across at the widest part," which in the same paper Mr. Wenham estimates as necessary to support the weight of a man. If to this we add the weight of motive power—for it is evident that man does not possess the necessary power—we might, but for other encouraging reasons, give up the hope of his ever being able to navigate the air, because its possibility, in the way that a bird flies, is held to rest either upon the necessary surface extended laterally or else superposed, and in either case—were the difficulty overcome—there would remain the important question of balance, which in the bird is maintained, I believe, similarly to that unconscious muscular action in the sole of the foot and leg, when a man stands in an upright position. Under such a surface, therefore, there would be, I maintain, no safety.

I grant that a light and very powerful motor would favorably alter some of these conditions, because the rapid vibration of a much smaller surface would effect the same result, but increase of strength of structure would be necessary.

I had hoped that some rotatory action, which would have presented to the air in rapid succession all the equivalents of flight by wing-surface, would have solved the difficulty; but the only attempt hitherto made in that direction has been effected by Mr. Moy, at a cost of several hundred pounds. The velocity which was requisite in its preliminary run was fatal to the attempt, because it could not be attained even if the machine had been effective on leaving the ground.

Then what has man to propose to evade these difficulties, which appear insuperable? Need I mention that he resorts to balloon propulsion in one of the various forms which are always recurring to minds who take freshly to the subject, and which are always supposed to be new?

Is there any need for me to dwell upon this negation of all hope for those who desire to navigate, and not to float and stagger about, in the air?

There remain, therefore, the advocates of the screw-propelled plane. For the lecture-room this is a very pretty and effective experiment, and I have propelled such for years with screws both fore and aft; but I have failed to see safety to life under such a surface, even were there not another objection, and that a fatal one, to their use.

I have always said that any aerial machine, to be safe, should have sufficient power to rise from the ground. It will then possess power to control its descent. But no plane has hitherto been devised capable of rising from the ground with any preliminary run which could be imparted to it. I have watched such experiments with much interest. Mr. Linfield's ambitious attempt failed to afford any indication of rising power, although he has traveled upon wheels at somewhere about 20 miles an hour, with a surface overhead of about 300 square feet set at an angle originally. The dimensions are: Length, 40 feet; width, 18 feet; height, 15 feet. The weight of all, including Mr. Linfield, is 304 pounds.

Mr. Moy also tried with a model weighing 1½ lb., also upon wheels, the screws actuated by twisted India-rubber, but he failed in my presence to effect any rise at all. He succeeded in attaining only 10 miles an hour.

The preliminary run with the velocity requisite for success seems to me to be fatal to any attempt of this nature—equally so any descent from an elevation—to attain the initial velocity.

The bird with extended wings does not rise by passively holding out his wings as a plane, but during his preliminary run he either slowly waves his wings or else tremulously vibrates them, which enables him to feel the air, and gradually to obtain a fulcrum upon it.

There is yet another group of inventors who hope, by presenting a suitable supporting surface to an accommodating breeze, to be lifted thereby, and then, by the aid of gravity and this friendly breeze, to sustain themselves like a kite, and even to progress when they get accustomed to the position.

For the last three years I have myself been a continuous experimenter, and one can scarcely work in any field of science without advancing a step in knowledge. Much more likely is the investigator to be rewarded if the field has been almost abandoned. Many a nugget has been dug out of a deserted claim. I will remark, however, in passing, that experimenters in flight are placed at a great disadvantage. The laboratory, or anything of the dimensions of a laboratory, would suffocate flight. Space and privacy are two necessities. The absence of these greatly deters progress, because for experiments in flight the object must *fly;* and we are necessarily, most of us, confined to models of small dimensions, which upon an increased scale would have more than a proportionate effect.

There is a mode of progression adopted by some fishes which is not reproduced by any flying creature, and in observing that motion—which was an undulating one—I asked myself whether in the air it would act also as a support? The fish is about the same gravity as the water; but how would the undulating motion of a loose fabric support a weight in the air? The result of my experiment was so satisfactory that it seems to me to get over the great difficulties that always suggest themselves in all plans except our own. For instance, in some designs which possessed encouraging features, there seemed a want of provision for a safe and gradual descent, so that a parachute naturally suggested itself as a necessary adjunct. But the addition of a parachute means weight, and also an incumbrance. In the loose material, however, which I employ, both for support and propulsion, there *exists* the parachute, which acts upon cessation of the motive power, and brings the machine down with a gently gliding motion in the direction of its travel.

In none of the plans which have been submitted to the Aeronautical Society has there been the slightest hint that flight could be attained by imparting a wave-like action to a loose surface extended in the direction of its length; nor do I well see how it would occur to any one to try the effect, unless he had been experimenting with flying models, so that he could readily substitute one arrangement for another. Certain it is that this discovery enables us to make a very large surface effective for support, which with wings alone appeared to be impossible. Of course, like every machine intended to find support in the air, it must be balanced; but in the model which I have made, such is its stability that an inch more or less does not affect it. So that we are at liberty to contemplate the construction of an aerial vehicle whose dimensions would suffice to maintain in wave motion six or seven hundred square feet of canvas, actuated by steam-power, and capable of supporting the additional weight of a man, whose weight, together with the machine, would certainly not exceed 500 lb.; and we can contemplate the man as being able to move a few feet backward or forward without much affecting the stability of the machine. His descent under the parachute action can thus be graduated at will. This can also be effected by a cord attached to the tail, which by that means can be elevated or depressed at pleasure. Placed upon wheels it has, of course, yet to be ascertained what distance of preliminary run would be required, assisted by the action of the fabric, before it would rise from the ground.

In Mr. Linfield's construction I see the framework required. The alteration would be flexible arms, and I think a looser arrangement of the cloth. The treadle action might or might not be able to vibrate the wing-arms. These flexible arms I construct of a bundle of canes, about 12 or 14 feet long, bound tightly together with whipcord throughout their whole length, and cutting off a cane every 2 feet or so in order to taper them. The wing-arm then affords lightness combined with strength, for it is almost impossible to fracture it. In this case we should be spared the weight of the screw, which is something considerable.

It has to be determined by experiment what velocity and what arc of vibration are best suited to the weight to be sustained. There will be also some relation between the arc of vibration of the wing-arm and the amount of surface in undulation.

In the model which I have made there exists a strong illustration of the assertion that any device made in miniature which will fly, can, when constructed upon a scale of utility, perform not only all, but much more than all, the promises extracted from it in the model form. In the first place, the experimenter is greatly in want of some motive power which will last sufficiently long to allow of close observation. Now in the recoil of the India-rubber which I have employed to produce the revolution of the crank which vibrates the arms, there exists only power sufficient to give a dozen strokes or so. And were I to increase the throw of the crank so as to increase the arc of vibration at the end of the wing, I should require so much greater power that either I could not with my own exertions wind it up, or else the parts would fail to bear the strain. For want of that continuous power I cannot say what amount of weight the model which I have made will carry, but I know this to a certainty, viz., that the weight to be carried depends upon the power and the strength of material for a given surface kept in a state of vibration. The weight of the larger model is 3 lb. 1¼ ounces, of which 7 ounces is added weight, which it easily carries. The dimensions are 6 feet wide by 10 feet long, with about 16 square feet of surface. By this arrangement of loose waving surface I have had the smaller model (5 × 8) fly from my hand perfectly horizontally to the extent of 60 feet.

What has assured me that there is a necessary relation between the arc of vibration, the velocity, the weight, and the surface, is the fact that through breakage I had to review the parts, and I have never since regained that chance relationship; but the model appears to descend until the loose fabric is seen to hold the air, so that if the ballast is behind the center of effort the surface is forced outward at an angle of perhaps 10°. Upon stoppage of the motive power there would then be no parachute action, but the machine would descend tail first. The ballast, however, properly arranged, the velocity of the model is increased, and the head being heavier, and power ceasing, onward motion continues under the concave extension of the surface.

All this would be at the command of a man with a power upon which he could depend. It is probable that if this wave-action were used in addition to a wing about a foot wide, a greater impact upon the air at starting might assist the supporting effort.

I perhaps need scarcely say that the judgment must be formed not upon the duration of flight or the distance traveled, but upon the effect observed in any part of its short flight which with my limited power I am enabled to give the model. It then becomes evident that we should only require a continuance of the power.

I think that after fourteen years' study of the subject by the members of the Aeronautical Society we are now in a far more favorable position than we have ever yet been to form a fair estimate of the probabilities of success.

The conditions necessary for flight are pretty well understood. There remain but the mechanical difficulties. How far those difficulties have now been minimized can only be satisfactorily determined by actual experiment upon a scale commensurate with the importance of the subject. And with respect to the model which illustrates this wave-action we may predicate for it that—largely constructed with power, strength, and surface—there would be as much difference in the effect as between a child's halfpenny toy, with four paper vanes pinned to the end of a stick, and the windmill whose larger vanes grind our corn.

* A paper read before the Aeronautical Society of Great Britain.

FIREPROOF PILLARS.

THE plan which we gave in the *Review* for June, of a safe pillar for architectural purposes—an interior solid core of wood and an outer thick shell of cast iron—has brought us several communications from manufacturers of composite "fireproof" pillars. In each case of these the center is a hollow circular iron core, with divergent flanges—the spaces between the latter being in one instance filled with oak wood bound with bands, and in others with fireproof blocks of clay or cement, duly clamped on with iron bands; and such posts are generally intended to be finished by plastering. We are glad to see these evidences of attention to an important subject, especially as one comes from Chicago, where such attention is much needed. We wish the manufacturers success, but think they have not commenced at the right point in their protective efforts. They seem to forget that the iron hoop clamps may burn off, and that anyway the heat, always above 180 F., *must reach the interior pillar;* then there will be expansion, throwing off the covering, or if not, the heat—without actual contact of flame—must weaken greatly the iron, and all the weight being upon it, the probability is it would bend and break.

We still hold that an interior solid wooden post, with an exterior cast iron shell of one inch thickness, would be safer than any of the composite patent pillars exhibited to us. The great danger in a fire is, that intense heat—we will not say flame—would reach the iron through even fireproof clay, for every one has seen that material red hot in cylinders of stoves; then, according to our views, as expressed in another article in this *Review*, intense molecular vibrations must ensue, which would weaken the iron, and the superincumbent weight of three, four, or more stories would aid to bear down the pillar.

In the pillar we suggested, the iron resisting fire would be supported against the weakness of its cohesion for a much longer time than if it were not assisted by the interior solid post of wood; and although the iron might become *red hot*, it would still shield the wood from the fierce flame. The outer pillar, if red hot, could but char the exterior of the wooden post, for there would not be air enough to support flame between the iron and wood. Meantime, in such a fire the outer iron pillar being red hot, and confessedly useless to bear great weight, the wooden post has assumed all the burden and upheld all the weight, which is what we claim it will do in any ordinary fire. The outer iron shell being thus relieved from pressure, remains in its place as a shield from flame, although it may become, as just stated, red hot, or even up to a white heat. The principle of no space left for air between the wooden post and the iron shell, is a point we strongly insist upon in suggesting this form of pillar.

As an evidence of how heat will penetrate terra-cotta ware, we will mention that a fire took place in a laundry on Marble street, above Tenth, Philadelphia, July 14th, where the shingle roof was set on fire and some damage done through a stovepipe surrounded by a terra-cotta pipe, which ran close underneath the bare rafters and shingles.

The difference between "fireproofing" a wooden and an iron *support* is this: Wood is strong against heat up to flammability; iron is weak against heat, but is fusible only at very high temperature, and not flammable, or very slightly so. The covering of the iron column admits the heat to the iron; the iron covering the wood largely keeps the wood from flaming.—*American Ex. and Review.*

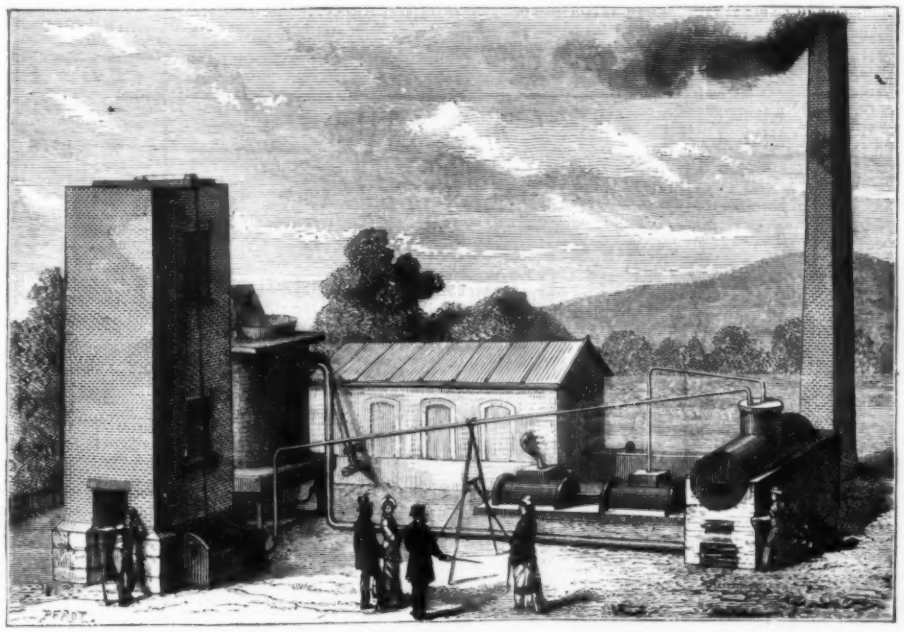
FURNACE FOR THE COMBUSTION OF REFUSE MATTERS.

THE animal and vegetable refuse from markets, the débris from kitchens, sweepings, and other materials of a like nature, which go to make up the waste matters of large cities, are objects of which all municipalities strive to rid themselves. At Paris these matters are calcined and form what is known as "Paris charcoal."

The apparatus shown on next page is designed for the combustion of all such refuse. It is the invention of Mr. R. Foote, of Stamford, Conn., who proposes therewith to destroy, by burning them, the waste products which accumulate in the vicinity of large cities, and to use no fuel in the process but the matters themselves, and this too without the production of disagreeable odors. As a general rule, organic matters superabound in these waste heaps, and often constitute ninety-four per cent. of the material; so there is always more combustible matter than is necessary for producing a heat sufficient to melt the mineral constituents. In producing a high degree of heat through the combustion of these organic matters, by means of a blast furnace, the non-combustible elements are fused and form scoriæ, which are entirely odorless, inoffensive, and capable of being utilized in different ways. The upper portion of Mr. Foote's furnace is of forged iron supported by refractory bricks. The whole is placed upon an iron quadrilateral supported by iron

columns. The fireplace is constructed of refractory bricks, and is shaped like an inverted cone. The sides of the furnace, not far from the base, contain orifices for the tuyeres. The refuse matters are raised, by means of a steam-elevator, to a platform, from whence they are dumped into the furnace over an inclined plane.

The gases from the top of the furnace, after having passed through an apparatus where they heat the air forced into the tuyeres, are led by pipes to the fireplace. The refuse matters are burned at the lower part of the furnace. The fire continues as long as the current of air is utilized, and while the matters are burning at the base a fresh supply is continually introduced at the top, so that the furnace is kept constantly full. The escaping gases are composed in



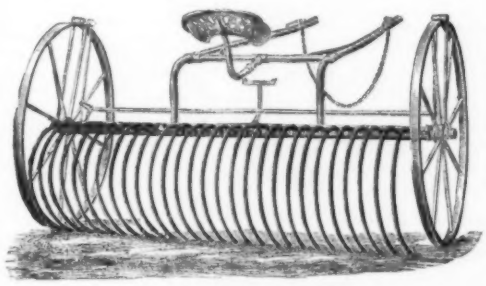
APPARATUS FOR THE COMBUSTION OF THE REFUSE MATTERS OF CITIES.

great part of carbonic oxide and carbureted hydrogen, produced by the distillation of the animal and vegetable matters, and make an excellent fuel for the fireplace.

The refuse matters on entering the furnace are first exposed to the drying action of the hot gases, and then to that of the burning products of combustion; their temperature rises in proportion as they near the tuyeres, and when they reach the fire they are dry and even inflammable. The mineral matters melt and form vitreous scoriæ, which flow outside. Here they are diffused through reservoirs of cold water, and thus converted into powder or fine sandy grains; or, if desired, they may, by proper manipulation, be converted into mineral wool.

THE "UNIVERSAL" HORSE RAKE.

THIS is one of the exhibits at the Kilburn Show. The distinguishing features of this rake are fewness and lightness of parts, combined with great strength, which is secured by the use of hollow tubes whenever practicable. Indeed, it is not too much to say that, for a given strength and sufficiency, one-third of the weight is saved, as compared with the ordinary run of horse rakes. In a normal state, the wheels, 50 inches in diameter, run loose upon the axle, which carries the teeth or tines, thus dispensing with one heavy bar. The tooth sockets are strung on the axle, which has a longitudinal feather running its whole length; and the sockets are provided with an internal slot rather larger than the feather, thus giving a little play to permit of sufficient rise over a stone or high place in the ground. Each of these annular sockets carries two teeth fitting into square sockets in projections at its side; and the teeth are carefully fitted in, but simply held by a split-pin, so that any tooth may be renewed immediately. The sockets are of malleable cast



THE UNIVERSAL RAKE.

iron, and the teeth are made from the best cast steel of a section in the form of a cross, rather longer than wide, for greater strength. As these teeth measure 70 inches from tip to socket, they gather an unusually large quantity of stuff. Strung on the axle with the tooth sockets are two rings of wrought iron, with short cylindrical projections, over which are fitted the hollow shafts, a couple of pins completing the joint. The footstep iron, also hollow, is fitted on in the same way, and the support for the driver's seat is, as will be seen, screwed on to a T piece on the shafts. A light hollow rod runs along slightly in front of the axle, within reach of the driver's foot, for effecting the delivery, which is accomplished by tightening the wheels on the axle and causing them to bring the axle, and consequently the teeth, round with them in their revolution. This is performed by very simple yet effective means. A ring keyed on the axle ends, outside the wheels, terminates in a vertical bar, reaching slightly above the rim of the wheel, and jointed to a short, flat band of iron serving as a clamp or brake. To the other end of this brake a similar rod, inside of the wheel, is jointed; and this may be drawn down by means of the horizontal bar depressed by the driver's foot, so as to clamp the brake on to the wheels. When the delivery is effected the tines are released immediately by removing the pressure on the bar. A link of India rubber, as being preferable to a steel spring, is interposed, for giving elasticity to this movement; and a simple hook of rod iron is attached to the footstep iron for holding up the tines clear of the ground for traveling. The spokes of the wheels are hollow, and screwed into the bosses; while the other ends are bent down and riveted to the rims. Brass lubricators are provided, which hold a sufficient supply of oil to last the whole day; and the usual stripping bar is added, which, however, is not shown in the illustration.

This machine is admirably suited for exportation, as the whole may be dismounted in five minutes; and it will pack in very small compass. All the joints are made with pins, not a single bolt or nut being employed. It is made in two sizes, differing only in width, with twenty-eight and twenty-four teeth, both of which were exhibited.

THE FARMER'S PESTS.

THAT rapacious bug which in the past five years has made sad havoc with our potato vines, is now much less troublesome than formerly. Farmers have so generally invited him to change his diet from a vegetable one to that of minerals, that his digestion has been fairly upset, and he has chosen death rather than life without his favorite food unmixed and simple. Paris green is no longer known only to chemists and painters; it is now an item on the farmer's list of purchases when he rides into town, as prominent as sugar or flour. "Another ton of Paris green just received" were the words observed to be chalked on the window shutters of a grocer's shop in a Western town, and thousands of tons of the great bug killer are manufactured by the chemists every week. It has proved a certain destroyer of the potato beetle, and without it we do not see how the favorite tubers could have long remained upon our breakfast or dinner tables. It is safe to use under all, or nearly all, conditions in which the potato is grown, and it is hardly worth while to expect, or look for, a better or safer destroyer of the beetles.

Another bug has strangely increased in numbers in the past two years, and it promises to be more troublesome than the enemy of the potato. The rose bug has come upon us in swarms, and it destroys not only our grape and peach crops, but our apples and plums if unchecked. The best method of checking him it is desirable to learn, if there be any method. We have tried hand picking, whale oil soap, and a variety of agents, but our efforts have been only partially successful. The white hellebore dust is the most effective destroyer, but it is expensive and troublesome to apply. It occurred to us this year to take our grapevines from their supports and lay them close upon the ground when in blossom. This course saved our crop so far as the experiment was tried, and we present the plan for the benefit of grape growers everywhere. The insect cannot or does not reach the blossom when the vines are in this position, and no injury results to the vines during inflorescence. As soon as the fruit is formed the danger is over, and the vines may be raised and secured to the supports. This we regard as important information, and it should be remembered. Our peach crop we saved this year by passing through the orchard and jarring the trees by a blow with the hand once or twice a day. The insects are detached from the fruit and fall upon the ground, and do not return to the fruit until after a considerable period of time. The better way is to place a sheet under the trees, catch the bugs, and destroy them in a pan of whale oil soap suds.—*Boston Journal of Chemistry.*

NEW CANALS IN RUSSIA.

DANILOFF'S grand canal system is under the serious consideration of the Russian government. It consists, first, of a canal of about 200 miles in length, from the river Terek to the water shed of the river Manytsch, which connects the Don with the Caspian Sea, but the bed of which is generally dry; second, of a canal about 213 miles long, from the mouth of the river Kalans, a tributary of the Manytsch, eastward to the Volga, near Astracan; third, of a canal from the same spot westward to the river Don, about 233 miles in length; fourth, of a branch from the eastward canal to the Serebriakowskaya Station, on the Caspian Sea; and, fifth, of a branch from the westerly canal to the Black Sea.

NEW REMEDY FOR THE POTATO BUG.

I EARLY started under glass a sufficient quantity of seed potatoes to make, say, forty hills, when transferred to my garden grounds. These vines being of early growth, I found, about a week ago, that they were infested with the potato bug. Without being exact in weight and measure, I dissolved, in a white glass quart bottle, a quarter of a pound of gum camphor in a half pint of alcohol of greatest strength. The camphor dissolved in a short time. I then filled the bottle with water, which, of course, reduced the alcohol below first proof. Before I added the full quantity of water the alcohol remained as clear as it was before the camphor was added to it, but with the full quantity of water it at once assumed a white, creamy appearance, and so remained without any deposit after standing several days. Of this solution I applied less than half of it to the potato tops, using a watering pot, the holes in the sprinkler being of small size. The next day, after applying my mixture, I carefully examined every potato top, and, to my surprise, I found that every bug had disappeared, and the aphides, which were very numerous, were all dead, not a single leaf showing an exception. As is well known, it is these latter parasites that rob our tables of good and sound potatoes. I do not know that my experiment will amount to anything, but if publicly known many might be induced to try it, as I have done, and, if successful, the public objection to the use of Paris green may be obviated. —*N. C. Nash, in New England Homestead.*

VASE FLOWER BED AT THE PARIS EXHIBITION.

OF the numerous flower beds on the slopes of the Trocadéro last summer, says the *Gardener's Magazine*, none evinced a greater originality of design, more skill in the disposition of material, or proved a greater source of attraction to the visitors than the vase bed planted by Mons. Gonesse, of Passy. This bed, as will be remembered by those of our readers who visited the Exhibition, occupied a prominent position on the Trocadéro lawns near the Anthropological gallery, and was of vast extent, and as novel in design as it was striking and attractive in appearance. By some visitors it was thought that the planter had attempted a representation of a dragon; but what was not only attempted, but most satisfactorily accomplished, was the portrayal of a gigantic bouquet of flowers in an elegant vase of colossal proportions. The accompanying illustration very clearly shows the character of the design, and as conveying some idea of the size of the bed and the immense amount of labor involved in the planting, it may be mentioned that no less than 25,000 plants were required in the formation of the bouquet and vase, independent of those necessary for the groundwork. To suggest its repetition would not, perhaps,

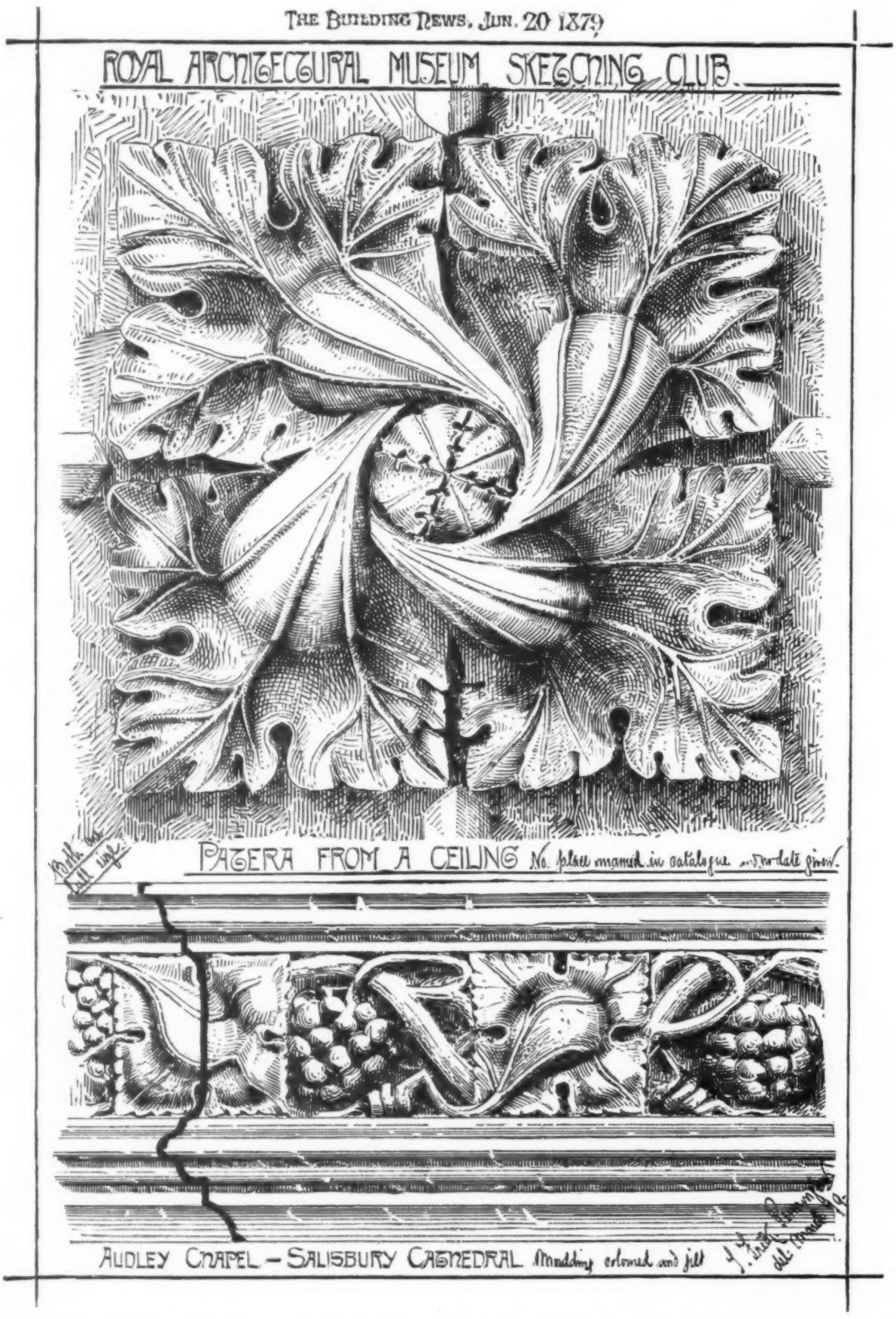
VASE FLOWER BED AT THE PARIS EXHIBITION.

be prudent, but there can be no doubt that a bed of this description in one of the metropolitan parks would attract much attention, and be "the talk of the town" for a season.

The references to the diagram are as follow: 1, Echeveria secunda glauca, which also is employed in the formation of the figures 1878; 2, Echeveria glauca metallica elegans; 3, Echeveria pachyphytum, this formed the center of the top flower from which the number has been omitted; 4, Echeveria glauca metallica rosea; 5, Echeveria globosa; 6, Alternanthera paronychoides; 7, Alternanthera amabilis; 8, Alternanthera amabilis; 9, Alternanthera versicolor; 10, Sedum lydium; 11, Sedum elegans; 12, Sedum sexangulare spiralis; 13, Sedum repens glaucum, employed in the formation of the flowers to the right and left of that in the center; 14, Sedum carneum; 15, Coleus Verschaffelti; 16, Coleus niger; 17, Coleus multicolor; 18, Achyranthus Comesti; 18, Mesembryanthemum cordifolium variegatum; 20, Golden Feather; 21, Lobelia compacta oculata; 22, Antennaria tomentosa; 23, Kleinia repens; and 24, Crassula Cooperi

ROYAL ARCHITECTURAL MUSEUM SKETCHING CLUB. — SKETCHES OF ORNAMENT FROM SALISBURY, ETC.

THE illustration of ornamental detail which we publish to-day is from the full size sketches by Mr. Pennington, made at the museum in March last. The enriched moulding is from the Audley Chapel, Salisbury Cathedral, and the beautifully designed patera from a ceiling is from a cast in the museum bearing no date or name.—*Building News.*


THE BUILDING NEWS, JUN. 20 1879
ROYAL ARCHITECTURAL MUSEUM SKETCHING CLUB.
PATERA FROM A CEILING No. please mamed in catalogue ... date given.
AUDLEY CHAPEL – SALISBURY CATHEDRAL Moulding coloured and gilt

FELT HATS, HOW THEY ARE MADE, AND THE DISEASES SUFFERED BY THE WORKMEN.*

By L. DENNIS, M.D.

INQUIRY reveals the fact that in the United States Medical Library at Washington there is no entire volume in English on this subject. Neither in the Astor Library in New York, nor in the Mercantile Library in the same city could anything be found on the healthfulness of trades in general, which facts would seem to indicate the need of an awakening of our individual physicians, as well as boards of health, to a more thorough examination of all the hygienic conditions of factory life.

A paper, by Dr. J. Addison Freeman, of Orange, on the "Mercurial Diseases among Hatters," appeared in the published transactions for 1860 of the New Jersey State Medical Society, in which it was stated that more than one hundred cases of this disease had occurred in Orange alone. The symptoms were "swelling and ulceration of the gums, loosening of the teeth, fetor of the breath, abnormal flow of saliva, tremors of the upper extremities, or a shaking palsy, and frequently some febrile action."

These cases recovered under the usual remedies for mercurial salivation, especially iodide of potassium, or without any treatment if the work was abandoned for a time. This disease occurred exclusively among the hat finishers, and the presence of mercury having been established by chemical tests in the hat bodies before going through the process of finishing, it seemed clear that the hot iron volatilized the mercury, and the close, ill-ventilated rooms favored the absorption of it in the system, and so the workmen were poisoned. The greater prevalence than usual of the disease at that time was found to be due to the use of a larger amount of mercury in order to render poor materials fit to work up into hats. The author suggested, therefore, that better material be used in the manufacture, in order to admit of the diminution of the amount of mercury, and that the finishing room be large and well ventilated.

Some time after a committee, of which Dr. S. Wickes, of Orange, was chairman, reported to the Essex County Medical Society substantially the same facts as those mentioned in Dr. Freeman's paper, and, after adding that most of the stock is imported, close their report as follows:

"The committee deem this a proper subject to bring to the notice of the State Society. In the eastern section of the State there is a very large number of this class of operatives, and they have a claim upon us, as conservators of the public health, to do what we can in their behalf. The facts in the case should be brought to the knowledge of our representatives in Congress, that such prohibitory laws may be enacted as shall secure the importation of proper and healthy materials. It may be proper to add that the importers have been appealed to by those interested in the hat manufacture, who declare that they cannot control or remedy the evil."

These two reports constitute all the available literature on the subject at our command. The dangers to workmen which they suggest as liable at any time to occur, and the fact that individual cases of the disease above mentioned come to the notice of the profession more or less frequently, prompted a more detailed examination into the whole business. To this end the wholesale dealers in furs, Messrs. White, 63 Broadway, and Hitchcock, Dermody & Co., 91 Mercer street, New York, were visited; also the factory of the latter firm on Park avenue, between Walworth and San-

* Abstract of paper from Report of the Board of Health of the State of New Jersey, 1878.

ford streets, Brooklyn, N. Y., in which are employed about 200 hands, then in full operation.

The factory of Messrs. White is situated in Danbury, Conn., and employs about 75 hands.

The following batting establishments in Newark and vicinity were also visited and inspected carefully:

[Here follows an enumeration of twenty-five establishments employing 1,589 hands.—ED.]

In order to make clearer the nature of the dangers to which the operatives are exposed in this business, a brief description is herewith subjoined of each process in the manufacture, from the crude fur to the finished hat. Ordinary felt hats are the only ones studied:

THE FUR FOR FELT HATS.

"The furs most largely used for the manufacture of hats are those of the hare, coney, and rabbit, all of them rodent quadrupeds belonging to the genus *lepus*, and differing mainly in size and the quality of their fur. The hare is the largest of the family, and its fur is the finest. Great quantities of the skins of these animals are brought from England and France, where the breeding of them for market is a regularly established business of considerable magnitude. The English rabbit has been domesticated in Australia, and for a few years past the importations from that country have been large and increasing. Many hare skins come from Russia, the fur being a longer staple than the English, but not as fine. Wild rabbits are found in large numbers in our Middle and Southern States, and their fur is extensively used, though hardly equal in quality to the best from Europe.

"For the finer grades of felt hats, and more especially for fur caps, nutria and beaver furnish the choicest material. They are both amphibious rodents, closely resembling each other in general appearance, the principal difference being that the former has a round tail, and the latter, a broad, flat one. The nutria is a native of South America, and is very prolific along the rivers of the Argentine Republic. The beaver is at home in colder climates, and flourishes in our Northern and Western States."

CARROTING THE FUR WITH MERCURY.

The preparation of the fur for hatting is termed "carroting," and the chemicals are called "carrot," from the fact that their action on the hair colors it yellow like the vegetable of the same name. A mixture is made, consisting of one pound of quicksilver, three pounds of nitric acid, and thirteen pounds of water; this is stirred with heat until the quicksilver is entirely dissolved, thus forming a strong solution of nitrate of mercury. This, with the aid of a short wisp brush, the hands of the workmen being protected by rubber gloves, is thoroughly rubbed into the hair, the skin being held firmly on an inclined plane, and the hair brushed both with the grain and against it, so that each hair, for about two-thirds of its length, is thoroughly wet with the solution.

These skins, when dried in a well ventilated and heated room, upon racks prepared for the purpose, are then sent to the brushing room, where each one is held upon a large, rapidly revolving, horizontal-cylindrical brush until the fur, matted down by the "carrot," is perfectly smoothed, freed from dust, loose hair, and the adhesive particles of dried nitrate of mercury. They are then sent to the cutting room.

"The machines which shave the fur from the skins are fitted with sharp, swiftly revolving knives, which remove the fur in an entire sheet, the skin being reduced to shreds. Then follows sorting of the fur into several grades, and packing in five-pound bundles."

The small fragments of the skins which are torn off in the process of scouring, together with clippings purchased from furriers, are carefully sorted; the larger pieces, and those having longer and more valuable fur, are laid aside to be cut by hand.

"The remainder of the furriers' scraps, and all the clippings from the skins used in the factory, are put into a cylindrical machine, and indiscriminately mixed by means of revolving skeleton wheels. They are then spread upon endless aprons, and are thus carried into the mouths of the cutting machines. These machines have teeth something like the ordinary thrashing machines. The skins are cut into small square bits, and the fur is removed after the manner of grain from the stalks. This hodge-podge of hide and fur is then screened. After passing from one machine to another, the fur is entirely removed from the particles of the skins, is thoroughly cleansed by the process, and is ready for the packers. This is called short fur, and looks like thistle-down."

It is sold to the hatters at a lower price, to be used with the more expensive stock as "filling in" material.

This process of "carroting" the fur is evidently the one in which there is greatest liability to mercurial poisoning, by reason of the concentration of that mineral in the wash employed. To guard against this, and also against the corrosive action of the solution, the hands of the workmen are protected, as stated above, by rubber gloves. In the establishment of Messrs. Hitchcock, Dermody & Co., the workman longest at this branch of the business had only been employed about six years. He stated that he had never had the tremors, but had suffered some from sore mouth and gums, and thought his teeth were beginning to be affected.

One of the Messrs. White stated that they have a number of old men in their factory, some of whom have at various times had the "shakes" and sore mouth, but that of late years there has been no complaint of these troubles since giving the workmen an abundant supply of fresh air.

He also stated that the demand for an increase of "carrot" in the stock has arisen within the past few years. The competition is so close and the margin of profits so small in the hat manufacture that employers are calling for a stock that will felt rapidly, and thus materially reduce the time and expense of production. He stated that the process of "carroting" with mercury is a French discovery, and was called "*le secret*," all knowledge of its use being for a time kept from other nations, and it being given out that only acids were employed for that purpose. Hence, for years, in the shops of Great Britain, "carroting" was done with a mixture of one pint of nitric acid and four parts of vinegar, and the felting was aided by mixing with fur a certain proportion of Saxony and Spanish lambs' wool. Consequently the workmen were entirely free from mercurial diseases.

EFFECT OF MERCURY ON THE FUR.

A microscopic examination of various specimens of fur which, by the kindness of Prof. C. F. Eickhorn, of Newark, were made with his instrument, magnifying about 850 diameters, revealed the fact that the action of the nitrate of mercury on the hair was to roughen its edges and deepen the natural depressions which exist on its surface, evidently thus favoring the adhesion and entanglements of the parts composing the felted mass. It will be readily understood from this why a fur of short fiber, or inferior quality, should need a greater amount of the "carrot" to cause it to work up satisfactorily, and why workmen are thereby more quickly poisoned. In some instances all the hands in a shop have, in a few days, been either rendered unfit for work or their health seriously impaired by handling stock so treated, compelling the employers to return it to the dealers as unfit for use. Just what, in a chemical way, is wrought by the "carrot," could not be satisfactorily determined in the time at my disposal. Some suppose the whole effect of the drug to consist in its dissolving from the fur the oily and other animal matters which coat its surface, and so prevent the felting. It is a matter of such importance, however, that he who should discover the exact nature of the change produced in the fiber of the fur, and be able to suggest some agent less harmful than nitrate of mercury for the accomplishment of the same work, would certainly be saving hundreds of workmen from much suffering, and very many from the premature wasting of their powers and possibly early death. We heartily commend the subject to the consideration of sanitarians, chemists, and microscopists throughout the country.

The fur prepared, as above described, is now mixed by weight and shaken together by hand in various proportions, according to the quality of the hat to be made, from one-half to one-eighth part being a coarse, poor material, called "shoddy," composed of short and inferior furs, trimmings of hat brims, etc., which is worked in with the finer qualities to save expense. This material is then passed through a machine called a mixer, in which the fur is passed between a pair of rolls and immediately seized by a cylinder, studded with wires, called a "picker," making 1,800 revolutions a minute, by which it is whirled to the top of an inclosing box. It then falls upon an apron and is passed through another set of rolls and over another "picker," by which the several kinds of fur are uniformly and properly mixed.

The same work is done in other factories by an instrument called a "devil," consisting of a cone set with spikes and revolving very rapidly in a case also set with spikes. A set of projecting flanges at the base of the cone produce a strong draught over its surface, and the fur, fed in an opening of the case near the top of the cone, is by this current drawn between the whirling spikes and sent flying in a cloud in a close room which acts as a receiver. Here, as in the other machine, all grades are perfectly blended. After mixing, the fur is placed in a machine called a "blower," somewhat similar in construction to the mixer, but having sets of four to six pickers. Just underneath each one and leading from it to an endless apron is a grating, so inclined as to catch bits of matted fur and pieces of fur with skin attached, called "dags," also all the heavy, long, and coarse hairs as, by their weight, they fall down from the revolving picker, which throws the fur to the top of a grated box, whence it falls upon an apron and is carried forward to another picker, and so on through the set, emerging from the last a delicate, fleecy mass, winnowed entirely free from dust, dirt, hair, and "dags." The "dags" are collected upon an apron and sent back to be again put through the machine, and at last are collected to be cut and torn for poorer material. The hair and other impurities are collected in a box underneath the machine and thrown away.

EFFECTS OF DUST ON THE HUMAN SYSTEM.

In this department the air is constantly charged with dust, so dense and heavy that everything is viewed through a cloud; and a stay of but a few minutes in the room produces in one unaccustomed to it a sense of dryness and unpleasant tingling in the nasal passages, with discharge of mucus, which lasts for several hours after leaving the building. Even the next day, sixteen hours after spending about forty-five minutes in the room, the mucus discharged from the nose was discolored with the same dust as on the previous day on just leaving the factory, showing that it had penetrated very deeply between the folds of the mucous membrane. Some of the hands wear a thin cloth over the nose and mouth while at work feeding the machines and receiving the fur from them; others use no precautions. Boys are mainly employed in this work, but some men were found who had been so engaged for ten to twenty years. Some complain of catarrh, bronchitis, chronic coughs, spitting of blood, and loss of flesh. Of thirty-nine hands, five are more or less affected. The dust is also loaded more or less with finely-divided particles of nitrate of mercury from the "carroted" stocks; hence, some have suffered from sore mouth and tremors. Of the thirty-nine workmen, eight cases of these diseases were found.

This dust seems less injurious to the bronchial surfaces than that from metals and minerals, perhaps partly from the fact that it is chiefly of an animal nature, and thus more readily softened by contact with the secretions of the mucous surfaces, and so loses part of its irritating properties, and, being lighter than the mucus, floats on the surface, and so is easily expectorated.

Another reason for this difference is suggested by an English writer thus. "Dust of every kind irritates, but not in an equal degree. Much, I conceive, depends on the size and figure of the particles which enter the air tube. The dust from the roads produces no apparent mischief, while the mason's chippings from the stone occasions serious and often fatal injury to his lungs. The dust from old iron, which is thrown off so copiously as to deposit a thick brown layer on the dress of the dealers in this article, produces no inconvenience, while the less apparent detachment of particles by the file is decidedly baneful to the workers in iron. It is, then, the form rather than the material—the spicular, the angular, or pointed figure of the particles detached, which we conceive the chief cause of injury. The bronchial membrane is mechanically irritated or wounded, and from daily repetitions of this injury the lungs at length become seriously diseased, and a vast majority die consumptive." In very few of the shops visited is any effort made to get rid of this dust. In some establishments ventilators have been put in the ceilings of the blowing-rooms, and one manufacturer stated that he had heard much less complaint of sore mouth since that change.

Without doubt, at a trifling expense, with the aid of a fan connected with the main shaft, a gentle current of air could be introduced at various points into these rooms, in warm weather from without, and in cold weather heated by a steam coil so as to make it comfortable for the workmen, and this, being allowed to pass out at the upper part of the room, would not only perfectly ventilate it, but carry off the greater part of the fine dust which now fills the room. If, in addition to this, the workmen were protected by close fitting respirators of cotton-wool, such as are recommended by Prof. Faraday, the greater part of the evil would be remedied.

FORMATION OF THE HAT BODY.

The fur is next weighed out into parcels of from two and a half to five ounces, according to the size and quality of the hats to be made. Each is then spread separately upon the apron of a feeding machine supplied with a revolving cylinder similar to a "picker," by which it is thrown forward upon another large roller, also studded with wire, which projects it forward and upward toward a large inverted cone in the Gill machine, open at the top, into which it is drawn by the action of a fan from the bottom. In the lower part of this open cone, upon a revolving pedestal, is placed a perforated copper cone, upright, between two and three feet in height, from whose interior the air is exhausted by the fan above mentioned. This latter cone being moistened and set in its place, and the door of the outer, enveloping inverted cone being closed, the fan draws all the inclosed air immediately toward the copper cone, and with it the fine spray of fur admitted to the top from the feeding machine. This fur, by the revolution of the copper cone, is then deposited in a uniform delicate thin film upon its surface. When the required amount previously weighed out has been laid on the cone, it is covered with a conical cloth, sides and top, over which a metallic cover is placed, and the whole removed to be immersed for a few seconds in a hot-water bath to contract and compact the material. The covers being removed, the cone is inverted and the felt gently loosened, stripped off, and laid aside for further manipulation. In the Burr machine the copper cone is fed through an open funnel, the fur being blown by a fan and suction made on the inside of the cone, as in the Gill machine.

The hat now consists of an immense open bag, which, when flattened out, measures from eighteen inches in breadth at the bottom by twenty-four in length for the smaller ones, to thirty by forty for the larger. It is first subjected to a process called "hardening," which consists of gently rolling and pressing it in a cloth from side to side and end to end, so as to interlace the fibers of the fur more compactly. At the same time it is examined closely within and without, and if there are any thin spots, they are patched with bits of fur with the aid of a brush, so as to make the body of uniform thickness.

DISEASES OF THE HAT BODY MEN.

The hands in this department are called "weighers," "feeders," "coners," "wetters," and "hardeners." The first two are handling only the dry stock; the last three the wet stock. The "coners" and "wetters" have their hands moistened constantly with water, in which there must be considerable nitrate of mercury in solution. Hence, fourteen out of seventy-four workmen, about twenty-five per cent., have had some form of mercurial diseases. The "hardeners" hold the damp hats on the arms, bared to the elbow, in order the more closely to inspect them by letting the light shine through, and so have a larger absorbent surface exposed to the action of the nitrate. Consequently, out of thirty-nine men examined, twenty-five, or over sixty per cent., are found to have had some form of mercurial disease.

Among these men inquiry revealed another class of ailments, evidently due to the same cause, namely, a wasting or a diminution in size, not very marked, but still noticeable, of the muscles, particularly of the arms from the elbows to the wrists; and this, notwithstanding these muscles were in constant exercise, and so ought to be expected to increase in size and strength. In one case, besides the general shrinkage, there was a distinct depression between the muscles of the left forearm, so deep that an ordinary lead pencil would lie in the furrow. This man had been working thirteen years at hardening. He complained of impaired memory, lack of power of concentration of his thoughts, had tremors and general muscular weakness; had not used stimulants for the last eight or nine years. Two others, working thirteen and fourteen years respectively, have the same mental symptoms, also increasing physical weakness and diminished size of muscles, though not so marked as in the first instance. Of the nine "hardeners" examined with reference to this in three shops, six were more or less affected, and one of those exempt had only worked in that department sixteen months. In view of this condition, and the special dangers in this department, our manufacturers should be cautioned against attempting to work up poor material at the risk of the health of their workmen. The mischief is evidently, at the present time, not due to imported stock, but to the effort on the part of our manufacturers to supply the market cheaply

The conical bag above mentioned is now put into the hands of the "sizer" or "maker," who reduces its dimensions to that of an ordinary hat by rolling it in a cloth and rubbing it back and forth with others on an inclined plank. Four to eight men work about one kettle of water, kept boiling by means of a steam jet. This water is acidulated with sulphuric acid, the action of this being to make the material felt more rapidly. Frequently the fingers are made sore at the edges of the nails, and occasionally, when the acid is used in too large quantity, the nails are eaten badly by it, and the fingers rendered very sore. These men are in a steam bath constantly, and in the winter time this is so dense that it is impossible to see more than a few feet in any direction in the room. The frequent dipping of the hats in the kettle, and the splashing and slapping of them on the planks, splatters the water over the bodies of the men, so that they are most of the time wet. Hence, in some cases, rheumatic diseases are found among them. About three per cent. of the workmen examined report this disease contracted in this room. Only two cases, however, of mercurial disease of the whole number examined who had ever been "makers," probably amounting to four hundred and fifty, ascribe its origin to this department. The comparative exemption of this class from disease is probably due to several causes. The rooms are, as a rule, better ventilated than any others in the factories. For while there is a very small average air space to each man, yet the lattice work in the upper part of the rooms, with which nearly all are supplied, is kept constantly open, and so furnishes an abundance of fresh air. The work is vigorous, and of itself would tend to develop strong, active bodies. It is possible, even probable, that the addition of the sulphuric acid and the supply of an abundance of water effect decompositions and recompositions of the salts of mercury, producing several less readily soluble than the nitrate, and thus less deleterious to the workmen. Time did not permit a more critical and chemical examination of this matter.

As a result of these combined causes there is a much larger proportion of old men here than in most other departments of the business, the average ages being only exceeded by those of the "hardeners," "clippers," "dyers," and "blockers," none of whom have as hard work as the "makers," and would, therefore, naturally draw the older

men to join them. Then, too, in past times it was customary for apprentices to learn several branches of the business, and as the finishers became incapacitated by age and disease from doing that work, they took position in the making-room. In examining the men at work, one would infer in this room the existence of a better state of health than in most others, from the exuberance of spirits manifested. In many cases there were singing and laughing; in nearly all loud, good-natured, hilarious talking, which was in marked contrast with the quiet of some of the other rooms.

STIFFENING, ROLLING, PRESSING.

After being sized properly the hats are sent to a drying-room, heated to a temperature of 160° to 170° Fahrenheit, whence they go through the hands of a workman who dips them in a solution of shellac, either the brim alone or the whole hat, according to the final finish desired, whether a stiff brim and a soft crown or an entirely stiff hat. They are then passed between a pair of rollers to press out any superfluous shellac, when they are ready for a second "sizing." This consists in passing them between a pair of rollers, on the surface of which are prominent raised disks, inclined at such an angle to the surface of the roller as to give, when in revolution, a wavy, back-and-forth motion. A number of the hats are rolled in a cloth so as to form a long bundle, which is then thrown in the midst of a set of four rollers of the above pattern, which turn it rapidly about, the disks giving a wavy motion to the surface of the rolls, and thus the size of the hats is still further diminished. They are now taken to the blockers to receive the first stretching into a shape resembling a hat. Here one machine rounds out the crown somewhat, another pulls it over a cylindrical-shaped block, and at the same time seizes the brim, turns it up, and stretches it into shape. It is now ready for the dyer.

DYEING AND COLORING THE HAT.

Ordinary black hats are produced by successive baths, composed of logwood, copperas, and verdigris. In the production of brown, blue, etc., the aniline dyes, bichromate of potash, many varieties of woods, and various other substances are used by different manufacturers, some of which are irritating to the hands of the workmen if they have sores upon them. Inquiry failed to discern any specially deleterious effect from these processes, though many workmen, and some employers, were found who believe the "shakes" and sore mouth are due chiefly to impurities in the dyes. After dyeing and drying, the hat is again blocked more thoroughly, when, after another drying, it is ready for "pouncing." After leaving the "makers," the processes of drying, stiffening, clipping, dyeing, and blocking seem to be comparatively free from disease. Only two cases of mercurial disease in the whole number of workmen examined refer their origin to either of these processes.

POUNCING THE HATS.

"Pouncing" consists in rubbing off, with the aid of a block of wood covered with a piece of emery paper, all the coarse, rough hairs, which in the process of felting the hat have gradually worked outward and are bristling from all parts of the surface. Formerly this was done by hand entirely, and the air of the rooms in which the men worked was filled with dust; the floor, walls, and ceiling were loaded with it. This dust was composed of particles of hair and fur, the "carrot" in the stock, and all the chemicals used in the process of dyeing. A few cases of disease of the respiratory organs, and also of mercurial disease, are referred, therefore, to this department. Of late years, in most of the shops, this work is done in good part by machinery. Rapidly revolving conical rollers covered with emery paper clean the brim, and another instrument sweeps over the crown set on a revolving block. Over each machine is placed an open funnel connected with a pipe leading to a larger pipe, the air from which is exhausted by a rapidly revolving fan, so that a strong draught is thus made. The dust and hair are rubbed off and swept out of the room at once, to the great comfort and benefit of the workmen. In the manufacture of white hats in the pouncing-room, preparations of French chalk or soapstone are rubbed into the body of the hat. No diseases seem to result exclusively from the use of these substances.

FINISHING.

Next in order of sequence, but first in importance in a sanitary point of view, is the process of finishing. This consists, in the case of black hats, in ironing off smoothly, with the aid of a little water, the whole hat, crown and brim, with a very hot iron, and shaping it to a particular pattern, if it be a stiff hat, upon a block or mould of the required dimensions. The workman is bending over the iron with his face but a few inches from his work, and this for the greater part of the working day.

DISEASES OF THE FINISHERS.

Here there are conditions favorable to the absorption of mercurial vapors, viz., the highest temperature to which the hat has been exposed in the whole process of manufacture, thus permitting the volatilization of the contained salts of mercury, and the position of the workmen favoring the inhalation of the fumes as they rise. Hence, of the 168 cases of mercurial disease whose origin is traceable, 107, or 63 per cent., are found to have arisen in the finishing department. Of the 438 men at present employed in this work, eighty-nine either now have, or have had in the past, some form of mercurial disease. Of that number only four admit that they now have the disease. This is accounted for in several ways. Several furriers, who are said to have used large quantities of mercury in "carroting" the stock, have gone out of the business. At the time these examinations were made, during the months of September, October, and November, all the windows and doors of the rooms were open, thus giving perfect ventilation, and preventing the breathing in of the mercurial vapors. Again, the style of finishing black hats has changed materially within a few years, less of what is called "glazed" surface being produced by the iron. The hatter now uses more moisture, and develops a soft, smooth finish without the gloss. The latter requires more persistent dry ironing, and would be likely, therefore, to volatilize more freely the mercury in the fur. It should be remarked in this connection also that, for one reason or another, many of the workmen examined seemed unaware that they had any disease, whereas a critical questioning would frequently reveal evidences of it. Many doubtless supposed they were answering honestly, having failed to notice slight indications of disorder, and so reported themselves well. For example, one of the hardeners above referred to, suffering from muscular weakness and wasting, reported that he had no "shakes." Yet, on being requested to stretch out his hand, there was a distinct tremor observable. Some were disposed to make light of the matter, and gave frivolous and evasive answers. Some, no doubt, had a false pride in regard to a confession of ill-health. Very few indeed would admit that the disease was contracted in their present places of work, and were rather disposed to charge it upon some other shop. In white hat finishing the dangers are much less, because the iron is used but little.

The subsequent operations, viz., trimming, flanging, and packing, were nearly exempt from all these forms of disease.

The trimmers attach the band, braid, and lining to the hat. These are usually young girls. They work in crowded rooms, often sadly ill-ventilated, as very little provision seems to be made for this in any of the factories. The average time in the business is short, for obvious reasons, many leaving it to enter upon married life. Hence, no conclusions are readily deducible as to the healthfulness of their work. Like all persons of sedentary occupations, they are rather disposed to look pale, thin, and worn.

The flange, or curl, in the brim of the hat is set on the mould by putting on it a bag of hot sand, thus dispensing with the iron. In this work, therefore, no complaint of disease is made. The packing consists simply in putting the hats in boxes for the market, and, of course, involves no greater dangers than the subsequent handling and sale of them in the stores.

INTERESTING FACTS AND SUGGESTIONS.

Each individual in the factories above mentioned was visited, and personal inquiry made as to all the facts in his history relating to the three classes of diseases specified. The dimensions of the rooms were taken, and the number of the hands in each. It should be stated that the time at which these inquiries were made was near the end of the busy season; consequently fewer men were found at work than are often engaged. The averages, also, are much raised by several instances of a few men being at work in very large rooms, *e.g.*, the packing rooms. In addition to what has been said in reference to ventilation in the blowing and pouncing rooms, particular attention should be called to the finishing rooms. Here the air is necessarily charged with poisonous vapors, and should be renovated by artificial means. The most that is done in this direction in any shop is the furnishing of a skylight or open funnel, with lattice work, to permit the free passage outward of the heated air.

No provision is made for forcing into the rooms a current of pure air from without, thus insuring their rapid and perfect ventilation. In this, the most dangerous work, the lowest minimum of air space of all is found, and the average is too low for health. Dr. Parkes estimates that 1,500 cubic feet of air per hour are necessary for each individual for healthy respiration. Of course, a larger volume still is needful if it be vitiated by poisonous chemical fumes in addition to the carbonic acid gas exhaled in the breath. It will be seen that with an average air space of 996 cubic feet to a man, as in these rooms, in order to support healthy respiration alone, the entire volume of the air of the rooms should be renewed every forty minutes. That this rate should be much increased when mercurial vapors load the air must be evident. All the manufacturers who have observed the health of their workmen agree in stating that mercurial diseases prevail much more extensively in winter, when the rooms are closed, than at any other time. The inference is clear, therefore, that wherever disease breaks out ventilation is insufficient. Undoubtedly, if an arrangement were employed for drawing off the air from the finisher's bench, such as is in successful operation in the pouncing room for carrying away the dust and hair, there would be very little complaint of disease from mercurial fumes. For so successfully does this little appliance act that the smoke from the pipe of a workman standing before it is drawn gently downward and swept out of the room. Much more would the fumes from the heated iron just in the mouth of the funnel be safely disposed of.

All degrees of severity of mercurial diseases reported are included in the two classes, from a trifling soreness of the gums and tongue to entire loss of teeth, and from a slight tremor of the hands and arms to such violent spasmodic jerking of the muscles as to render the patient incapable of feeding himself or carrying a cup of fluid to the mouth without spilling the whole or the greater part of it, the latter being accompanied by great loss of strength and manifest impoverishment of blood.

One hundred and seven report having contracted the mercurial diseases in black hat finishing, but a number of those are not now engaged in that work, having gone to other departments, since but eighty-nine now report the disease in that room.

Hence, two sets of figures were necessary, one to represent the present condition of the men, and the other to indicate where, including both past and present, the greatest amount of disease had been developed. "Mixers," "blowers," "weighers," "feeders," "hardeners," and "finishers" have developed most mercurial diseases; "makers," most rheumatism; "mixers," "blowers," and "pouncers," most respiratory diseases. The reasons for these results are evident from the description of the processes carried on in the respective rooms. Assuming that the numbers employed in the past are about the same as at present, in the classes first mentioned we have one hundred and fifty-nine cases of mercurial disease to five hundred and ninety workmen, an average of about twenty-seven per cent.

In order to make some estimate of hereditary influences, the occupation of the father was ascertained in each case. Of the number of those whose fathers were hatters (265), twenty-six report having had mercurial disease. About thirteen per cent. of those whose parents were not hatters had the disease, whereas only eleven per cent. of those whose parents were hatters developed it. These figures are insufficient, however, as a basis for any general conclusions.

In conversation with the employers as to the diseases to which their men were subject, in fully three-fourths of the cases the statement was made that the chief cause of ill health among them was intemperance. Since all writers on the articles used as medicines represent muscular tremors as one of the most common effects of the excessive and long-continued use of alcoholic stimulants, it seemed necessary to inquire what proportion of the men were addicted to them in order to judge, if possible, what influence this might have on the disease. Each class represents a condition of things sufficiently deplorable to fully justify the statements of the manufacturers. Again, Dr. Phillips, of England, a careful writer on *materia medica* and therapeutics, says of the chronic effects of tobacco: "General nervous depression has frequently been produced, showing itself in restlessness, insomnia, and a tremulous condition of the limbs, not very unlike the phenomena of chronic alcoholism." Dr. H. C. Wood, of Philadelphia, says of nicotia in poisonous doses. "In one or two instances violent muscular tremblings have come on shortly after the ingestion of the poison, and ended in general clonic convulsions." It is worth considering, therefore, how far the constant and excessive use of this drug may have assisted in the production of this class of diseases.

The data here likewise are insufficient, since the element of time is not taken into account. Independent of that, however, taking only the classes of work in which the men have had the "shakes," out of twelve hundred and twenty-eight hands, there are found eight hundred using stimulants and tobacco, with eighty cases of shakes, ten per cent.; one hundred and six using stimulants, but not tobacco, with eight cases of shakes, seven per cent.; two hundred and sixteen using tobacco, but not stimulants, with twenty cases of shakes, nine per cent.; seventy-five using neither, with eight cases of shakes, ten per cent.

Of the whole number of persons examined, leaving out the weighers, feeders, and trimmers, who are girls, and who do not, as a rule, use either stimulants or tobacco, there are left 1,230. Of these, 919, or 73 per cent., use stimulants, and 1,035, or 82 per cent., use tobacco. Of course, very many of them use both to excess, thus wasting hard-earned wages, undermining health, destroying the peace and prosperity of families; and in some cases preparing the way for entrance into our prisons and poorhouses. He who shall succeed in so vividly and truly painting the dangers attending the use of these two articles as to deter healthy men from taking them will confer a priceless blessing on humanity. Perhaps more is to be looked for from early training than any other agency, and it is incumbent on every sanitarian to urge the necessity of teaching thoroughly in all our public schools and institutions of learning the laws of sound health and right living. It may safely be assumed that one of these fundamental laws would teach that, to the human body in a state of health, both stimulants and tobacco are not only worthless, but positively detrimental.—*Sanitarian.*

PAPER BAGS.*

Paper Bag Machine.—This machine is usually automatic, operating upon paper from the roll or upon blanks previously cut, to fold and paste it into bag shape.

The kinds are various, and the prominent ones will be cited in order of date. The principal and most successful ones take the paper from the roll, either of a width for forming a bag, or else cut into strips which are simultaneously acted upon by separate sets of devices. The strip, assuming there to be but one, is bent over into tubular shape, cut off into lengths, the shape at the point of severance being such as to leave a flap to paste over, and thus close the bottom; or a piece is cut off the flat strip and portions of it are folded over the remainder and flaps pasted for closing the side and bottom; or a piece is folded into a conical form with pasted flap. Other minor variations might be cited. Much of the ingenuity has been expended in cutting the paper to make no waste; also in forms for so folding the portions at the bottom as to make what is called a satchel-bottom, where the parts are folded upon each other, making several thicknesses at the part most exposed to wear and tear.

Fig. 1 is a hand machine, having two ends at which square and conical bags are made respectively. In such case, a piece of paper of the required size and shape is laid upon

FIG. 1.—PAPER BAG MACHINE.

the table and held by a hinged piece which corresponds to the inner size and form of the bag; this former holding down the sheet, side flaps are folded over, carrying with them portions of the paper which lap upon each other a sufficient width for a pasting surface. One machine is shown operated by a hand lever, the other by a treadle. The farther one, for square bags, has a bottom flap for the bottom piece, which folds over upon and is pasted to the side pieces.

Wolle, October 26, 1852, and May 29, 1855, was perhaps the first to make bags by automatic machinery. The bag made is shown at *a a'*, Fig. 2; *a* is the blank with a notch; the portion 1 is folded over the part 2, and then appears as represented at *a'*. The folding over of the top and bottom

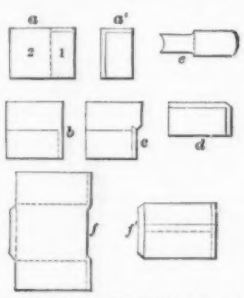


FIG. 2.—BLANKS FOR PAPER BAGS.

flaps finishes the operation. The paper is fed from a roll, the web is cut into oblong sections, notched, folded by a blade which drives the bottom edge between rollers, from whence the folded blank passes to the gummers and flap folders.

b c d shows a bag in successive stages as made in Wolle's machine of July 6, 1858. The piece is not removed to form the notch, but is folded in to make double the bottom of the bag.

* From Knight's "Mechanical Dictionary," published by Messrs. Hurd & Houghton, New York City.

The Rice machine, April 28, 1857, was the first to bend a continuous web of paper over into a tubular shape and cut it off obliquely, so that an angular piece is left to be bent over and form the flap of the bag bottom.

e represents a blank cut from a continuous web in a Goodale machine, May 29, 1855. The narrower portion is folded on to the wider, and the side flaps pasted and turned down. The bag has a projecting lip, due to the curved line of severance.

f f' shows Goodale's paper bag, July 12, 1859. This cuts from the web without waste, and the bottom has two flaps, strengthening it at that point. See also his patent, Aug. 23, 1859.

Koch's paper bag machine, March 13, 1855, is adapted for making bags or boxes, the paper from a continuous web, *a*, being drawn between successive sets of rollers, etc., which

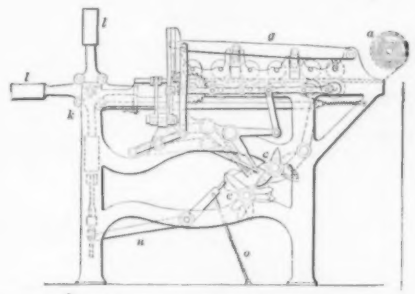


FIG. 3.—KOCH'S PAPER BAG MACHINE.

are caused to turn intermittingly in one direction by means of cams on a shaft operating jointed levers and connecting rods. As the paper moves onward it is cut to the proper form and size by a cutter or cutters vertically reciprocated by the lever, *g*, which, together with a corresponding lever on the other side, derives its motion through an intermediate series of levers from cams on the shafts, *c c*. The lever, *g*, also operates the paster.

After being pasted the blank is carried forward by the two succeeding pairs of rollers and received upon a slide which forms one side of a hollow mould within which the bag is formed; at the same time the shaft, *k*, is rotated one quarter around, so that one of the formers, *l*, is in proper position to permit slides corresponding to the three other sides and the bottom of the bag to be successively brought up against it; this is effected by cams on the shafts, *c c*, which operate compound levers connected with the slides and having toes against which the cams strike during the rotation of the shaft.

The forward movement of each slide turns in its side of the paper upon the former, *l*, and joins the pasted edges. The bottom is also similarly turned in and united to the sides. Farther rotation of the shafts, *c c*, causes the withdrawal of the slides and imparts a movement to the *former*, on which is the completed bag. This is withdrawn from the *former* by a pair of nippers or pincers, which are caused to rise at the proper moment and seize the bag, by the bent lever, *n*, actuated by a spring, *o*. The nippers is withdrawn, taking with it the bag, by a semicircular cam on the shaft, *c*, its jaws being opened and closed at the right time by projections on the standards between which it works.

Pettee's machine, May 29, 1860. The roll of paper is fed beneath an elevated roller, and passing over and partially around a drum, passes beneath the folder, which consists of two longitudinal strips with an opening between them, through which one edge of the paper projects, enabling paste to be applied by means of a horizontally revolving paste wheel. Passing onward it is seized by two clamps, drawn over a slide, and the two sides united so as to form a tube. As it is released by these clamps it is seized by a second pair, which pass over the first, drawing it forward by a hand-over-hand movement, and passing it between the two blades of a stationary clamp, which holds it while it is severed by a reciprocating knife. It is then subjected to the action of a wedge shaped trough containing paste. The lower edge of this trough has a longitudinal slit, the width of which may be adjusted so as to deposit the proper quantity of paste on the bottom of the cut-off bag. At the moment of depositing the paste the edge of the trough forces this part between two rollers, which bend over the edge of the bottom and complete the bag. The various motions requisite to the operation of the machine are derived from a driving shaft, having belt and pulley connection with the motor.

g, Fig. 4, represents the Armstrong machine, October 2, 1860. The bag is made from a continuous web, bent by a spindle shaped roller and by side guides into a tube, the

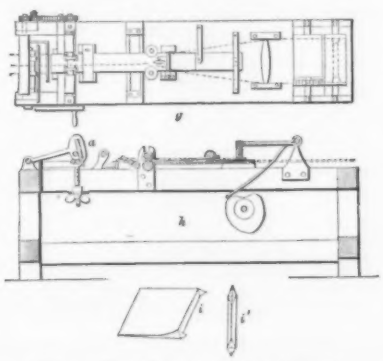


FIG. 4.—PAPER BAG MACHINES.

lapping edge pasted, the tube flattened, and then a bag cut off. The sides of the bag are held apart at different parts of the length of the tube, so that a single stroke makes an oblique cut across the tube of paper. The projecting serrated flap is pasted and folded over upon the body of the bag.

Greenough's machine, February 3, 1863, works from a continuous web, making square bottomed, box shaped bags, portions being removed from each side of the strip to make the requisite indentations and flaps.

Pettee, May 5, 1863, bends a continuous web of paper into a trough shape by a pair of rollers adjustable in relative distance according to size of bag. Then the edges are bent over by another roller to form a tube, the edges gummed, a portion cut off obliquely to make a bottom flap.

Taggart, August 15, 1865, has a table with a slit which holds the flatly folded bag, exposing that portion above the table which is to be folded satchelwise.

h is the Goodale machine, September 12, 1865. The continuous web is cut by the descending knife, *a*, giving the edge of the blank a wavy shape. The sides are then folded over by side flaps, the folded portions lapping over each other the width of the pasted surface. The bottom flap is turned over and pasted on to the sides.

i i' are two views of the Hollingsworth bag, January 24, 1865, which is made upon a vertical former with dilatable sides.

Jaegar's machine, May 7, 1857, is shown in Fig. 5. It is somewhat similar to the one shown at Fig. 4. It takes a square blank and folds over two angular flaps, making a conical bag.

Mallary's machine, July 28, 1868, like the Goodale machine just cited, has side and end flaps which fold those portions over the former. As the continuous sheet of paper is fed to the machine, the several devices perform their respective functions of delivering the paper to a knife, which cuts off a piece of suitable length for a bag, drawing such piece into the folders which produce the side laps, pressing the end lap against the pasting roller, and at the same time turning it upward over the edge of the folding blade, and then moving the bag forward between pressure rollers, which join the pasted edges of the laps to the bag.

In his patent of November 3, 1868, one edge of the sheet is pasted by means of a roller as it passes into the machine; then one of its sides is folded over a former, and over it is

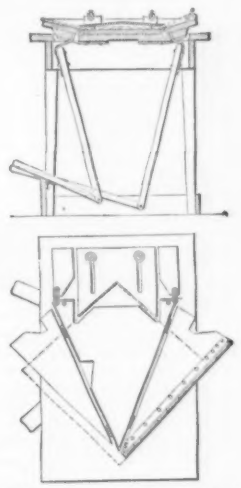


FIG. 5.—JAEGER'S PAPER BAG MACHINES.

folded the pasted side. The bag so far formed is drawn off by rollers, by which it is passed into an inclosure made with a bottom of a series of rollers, which carry it forward. One roller applies paste across the bag near the bottom, while another forms a fold for the bottom lap. It then passes out between another pair of rollers, which dress the bottom fold of the bag into place.

In Amazeen's machine, November 17, 1868, the paper in passing into the machine from a mounted roll, has paste applied to its margin at one side, and is fed forward to toothed knives, which cut off a piece large enough to form a bag. The pasted and detached piece is then made to pass on beneath a plate or former, around which it is deflected into tubular form by bent guide plates. The paper, being delivered from this forming device, has its pasted side pressed down upon the adjoining edge. One side of the paper tube is now longer than the other (a result due to the shape of the knives), and the mechanism, which finally comes into play, applies paste to the projecting end, folds it over to finish the bag, and discharges the latter from the machine.

Lockwood's machine, March 9, 1869. The web of paper is drawn over rollers, *a d*, paste being applied to one edge by a roller in the trough, *f*. It is partially formed in a tubular shape by the pivoted ball, *g*, which prepares it for the action of the former, *h*, by which, and the side clamps, *i i*, the two edges are thrown over toward each other, but are prevented from touching by a finger until arriving at or near the guides and press rollers which unite the two edges.

The tube is passed onward by a roll and endless band, which hold it firmly while being severed between the stationary serrated knife and a movable knife below it. The endless belt, *n*, conveys the bag into a position to be acted on by a knife, which is brought alternately into contact with a roller revolving in a paste trough and with the end of the bag, which it pastes and creases preparatory to being seized by the rollers, which by pressing the turned over portion and the body of the bag, form the bottom and complete the operation.

M. E. Knight's machine, July 11, 1871, manufactures flat or satchel bottomed bags from a continuous tube of paper fed from a roll over a former, and cut, folded, and pasted. The peculiar feature is a device to hold back a point or portion of one edge of the paper tube, while the blade or tucking knife makes the first fold.

In Arkell's machine, December 26, 1871, square bottomed bags are made from a roll of paper which is passed over a former, and its edges pasted together so as to be delivered in the form of a tube, which is cut into lengths, one end of which is cut, folded, and creased to facilitate the operation of forming the bottom. The partially formed sack is carried automatically through the machine on a carrier, which moves continuously in one direction, and on which it is subjected successively to the mechanism for applying the paste and finishing the bag bottom.

The Benner bag, January 9, 1872, is composed of a strip double the length of the bag to be formed, folded at mid length. By the action of long formers, having at their sides hinged blades, the edges of the blank are folded, reverse folded, and lapped to form a tube which, when distended, is rectangular in section. See also Guild's patent, January 23, 1872.

Bibby & Baron's English machine, October 1, 1872, for making square bottomed bags, takes the paper tube from a roll, cuts, pastes, folds, presses, prints, and delivers the completed bag.

Annan's machine, November 12, 1872. A strip of paper, one edge pasted, is fed over curved guides (carrying diagonal spreading rolls) attached to pivoted lever arms, and its sides turned inward and lapped by twisted guides. This tube is pressed and fed forward by rolls (between which it is cut) upon a folding table, where its lower ply is held down and the freshly pasted seam protected by an exhaust through orifices in the bed, and the forward end of the upper ply blown up by a blast through a pipe. Three rollers, journaled in cross heads which reciprocate in radial slots of the revolving frame, successively carry the upper ply back on the tube to form the first diamond-end fold, the tube having been clamped by fingers at the angle thus formed; then deposit two lines of paste over the lape clamped by double fingers at the points where they are next to be folded, and after a folding plate has folded over the last flap, then lap the last fold on the opposite end of the bottom, the finished bag being fed out by rolls or belts.

In Hotchkiss' machine, January 28, 1873, the bag is formed from a continuous sheet of paper fed by rolls from under the delivery table over the recess of the folding table, where it is held on one side by a spring, and on the other by a gravitating bar, when a bag length is cut by the shears. A right angular bar, rocked in and out of a vat, applies paste to one edge and part of the rear end. The rectangular former, descending, carries the blank into the forming box, causing its sides to stand vertically, that which is dragged from under the bar being longest to form the overlap or seam. The folding plate moves forward to lay one lap, followed by the opposite combined plate and roller, which lays the other flap and completes a square tube. These folding devices are so connected by levers that one shall move in advance of the other, and the last folder plays under the pasting table. The side end folders are reciprocated successively to lay the side folds of the bag end, the pasted one first, over which partially completed end a paste roll, vibrated out of a paste vat, lays a line of paste on the inside surfaces of the top and bottom end folds, the latter being protected by a supporting lip. The side folders retreating, the upper end folder descends and lays its fold, and retreating is followed by the lower end folder, which completes the bottom. The *former* now rises, and as a new feed is accomplished, its interior piston ejects the bag from the former on to a table, from which it is fed by an apron against the upper of a pair of rolls, where a vibrating bar breaks down its upper edge and forces the lower corner of the bottom into the bite of said rolls, which press and deliver it flat.

Fig. 7 shows the Crowell bag, April 8, 1873, in which the edges of a strip of paper are folded in and then a portion lapped outwardly, the face of the latter being pasted. By doubling the strip thus prepared inward and outward, zigzag fashion, as at *m*, the parts become united together in pairs, faces fastening paste to paste, and alternating with unpasted portions lying back to back. The bolt thus made is cut along the edges *m'*, which separates the pile into bags which are like *m*" when fully distended. See also his patent October 14, 1873, in which the paper is cut longitudinally, intermittingly pasted by the paste wheels and scraper, the edges then being folded under and paste applied to them. Thence it passes over a cylinder between it and a second cylinder, when the bottom is folded, the bag length cut off,

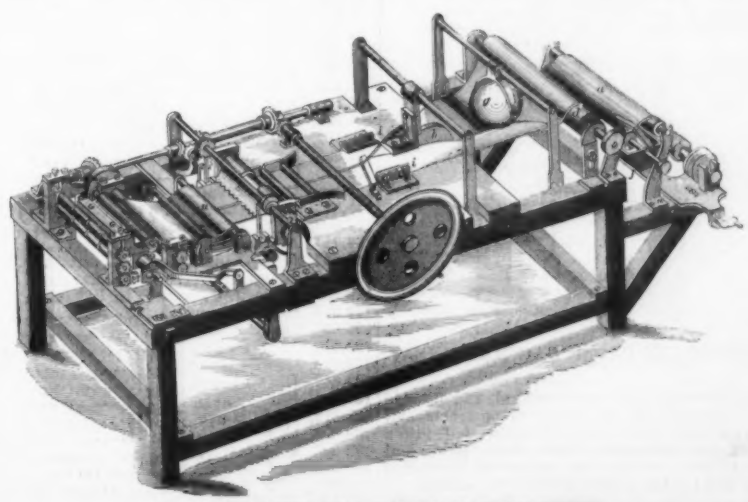


FIG. 6.—LOCKWOOD'S PAPER BAG MACHINE.

and the edges pressed together. Then the bag passes over the printing roll to the table, where it is automatically removed and counted.

n represents the Parker bag, January 6, 1874, which is formed by folding inwardly the opposite edges of two strips of paper, uniting the folded edges, and folding and pasting one end of the united strips.

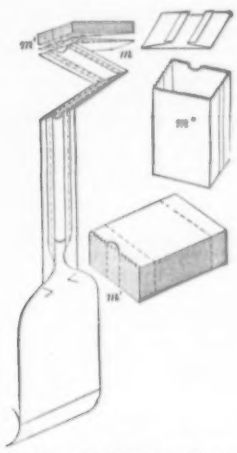


FIG. 7.—CROWELL BAG.

Crowell's paper bag, January 13, 1874. *o* has a bottom made by a central transverse fold of the paper, and has its sides closed by edge folds which, at each side of the paper, are cemented together and to one of the adjacent sides of the bag.

*q q*¹ illustrate Murphy's mode of making the division of the paper tube so that when the side portions, which are deeply serrated, are folded over upon the mid portion, both will be exposed to the pasting brush, as shown at *q*, and may be securely fastened down to the side of the bag over which the bottom flap is folded.

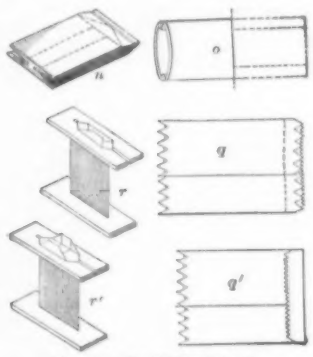


FIG. 8.—PAPER BAGS.

*r r*¹ illustrates the mode of making the Taggart bag, the blank being slipped into a slit plate, and then the portion projecting above the plate being folded down, first the ends and then the sides.

Biedinger's, March 10, 1874, is an upright machine in which the web of paper is fed upon its edge between a pair

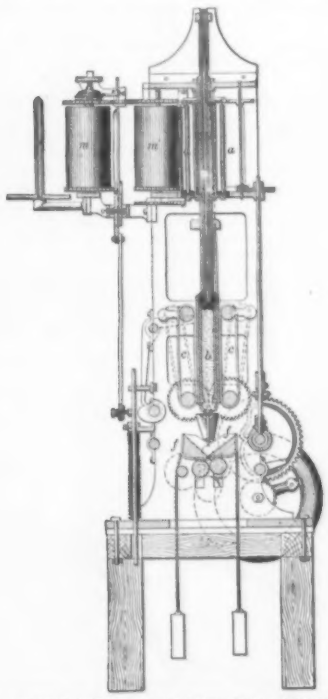


FIG. 9.—BIEDINGER'S PAPER BAG MACHINE.

of vertical rollers, is wound around a mandrel, and its side joint pasted, the bag cut off, the mandrel contracts and allows it to slip on to a former. Its bottom then falls into a cradle formed of revolving cams, where folding pieces and fingers combine to bend over the flaps which constitute the satchel bottom; and the bag passes between the rollers.

To describe it somewhat more at length: Main feed rolls, *m*, deliver the web to shears and cease their motion as a bag length is cut. This blank is carried forward by auxiliary feed rolls, m^1, seized by a gripper and wound on the *former*, the forward end receiving paste from a roll and being united to the rear end by pressure against the delivery roll. The *former* consists of a set of rolls, *a a*, on eccentric shafts, partially rotated, to expand the *former* while making the tube, and farther rotated to contract it to release the tube, which falls on to a supplemental former, *b*, over which it is fed by endless belts, *c c*, being made to pass over spring arms and extended flat, and into the discharge rolls, which propel it until a proper length projects above the bottom folders. Folders, *f f*, now move inwardly, pressing against the retiring spring arms, and form the triangular end folds (Fig. C); retracting, they are followed by the descending piston, which rests on this partial bottom (Fig. D). The continu-

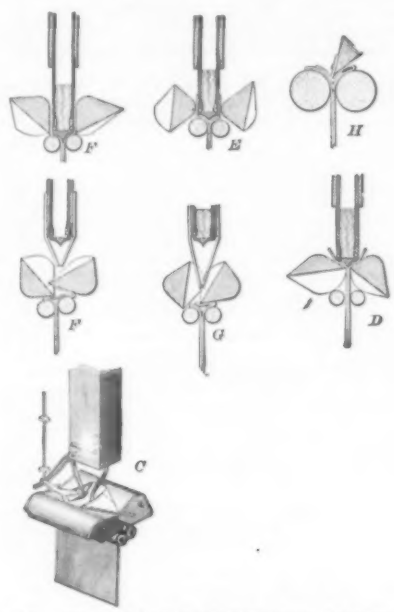


FIG. 10.—BIEDINGER'S PAPER BAG MACHINE.
(SERIES OF OPERATIONS.)

ously revolving folders crease the sides against the angles of the piston, press a line of paste thereon, carry the piston and bag downward together until the central rib of the piston enters and spreads the bag bottom in the bite of the discharge rolls (Fig. E), where, the piston rising, the folders lay the side laps successively (F, G), one folder (Fig. H) carrying a knife, folding the bottom centrally and into the rollers which discharge it flat pressed for packing.

PAPER BAG MACHINES PATENTED IN THE UNITED STATES.

No.	Name.	Date.
9,355,	F. Wolle	Oct. 26, 1852
12,511,	Louis Koch	March 13, 1855
12,786,	Smith and Pettee	May 1, 1855
12,945,	E. W. Goodale	May 29, 1855
12,982,	F. Wolle	May 29, 1855
13,647,	E. W. Goodale	Oct. 9, 1855
17,184,	B. F. Rice	April 28, 1857
19,506,	Jacob Keller	March 2, 1858
20,838,	Francis Wolle	July 6, 1858
21,657,	Henry R. David	Oct. 5, 1858
22,199,	S. E. Pettee	Nov. 30, 1858
24,734,	William Goodale	July 12, 1859
25,121,	William Goodale	Aug. 23, 1859
27,959,	Louis D. Barrand	April 24, 1860
28,188,	G. F. Lufberry	May 8, 1860
28,537,	S. E. Pettee	May 29, 1860
30,191,	H. G. Armstrong	Oct. 2, 1860
32,777,	John Miller, Jr.	July 9, 1861
37,573,	J. J. Greenough	Feb. 3, 1863
37,726,	C. H. Morgan	Feb. 17, 1863
38,253,	Joseph Wells	April 21, 1863
38,452,	S. E. Pettee	May 5, 1863
40,001,	Joseph Wells	Sept. 15, 1863
42,313,	Joseph Wells	April 12, 1864
43,773,	J. M. Hurd	April, 12, 1864
45,999,	E. A. Hollingsworth	Jan. 24, 1865
49,454,	B. B. Taggart	Aug. 15, 1865
47,736,	B. F. Ellis	Sept. 5, 1865
49,951,	E. W. Goodale	Sept. 12, 1865
62,342,	Kirk and Howlett	Feb. 26, 1867
64,537,	G. L. Jaeger	May 7, 1867
70,601,	E. B. Olmsted	Nov. 5, 1867
74,190,	James Arkell	Feb. 11, 1868
80,298,	George H. Mallary	July 28, 1868
83,648,	George H. Mallary	Nov. 3, 1868
84 076,	C. Amazeen	Nov. 17, 1868
87,608,	Joseph Wells	March 9, 1869
87,689,	H. C. Lockwood	March 9, 1869
90,624,	C. F. Annan	June 1, 1869
94,511,	J. P. Pultz	Sept. 7, 1869
101,299,	C. J. Moffatt	March 29, 1870
104,169,	H. Law	June 14, 1870
105,099,	Lorton and Davison	July 5, 1870
110,536,	C. F. Annan	Dec. 27, 1870
111,802,	C. F. Annan	Feb. 14, 1871
111,803,	C. F. Annan	Feb. 14, 1871
112,005,	P. E. Armstrong	Feb. 21, 1871
114,743,	A. Adams	May 16, 1871
116,842,	M. E. Knight	July 11, 1871
118,327,	James Arkell	Aug. 22, 1871
119,307,	J. M., J. P., and S. H. Bryant	Sept. 26, 1871
119,915,	B. S. Binney	Oct. 17, 1871
122,099,	James Arkell	Dec. 26, 1871
122,510,	L. D. Benner	Jan. 9, 1872
123,013,	George Guild	Jan. 23, 1872
123,812,	L. C. Crowell	Feb. 20, 1872
131,841,	Bibby and Baron	Oct. 1, 1872
132,312,	H. B. Morris	Oct. 15, 1872
132,890,	C. F. Annan	Nov. 12, 1872
133,395,	J. Arkell	Nov. 26, 1872
134,035,	B. Cole	Dec. 17, 1872
134,580,	C. F. Annan	Jan. 7, 1873
135,145,	M. Murphy	Jan. 21, 1873
135,275,	T. Hotchkiss	Jan. 28, 1873
138,844,	L. D. Benner	May 13, 1873
139,104,	H. G. Armstrong	May 20, 1873
140,342,	N. Biedinger	July 1, 1873
141,862,	G. Dunham	Aug. 19, 1873
143,358,	W. Liddell	Sept. 30, 1873
143,674,	L. C. Crowell	Oct. 14, 1873
143,925,	J. S. Ostranger	Oct. 21, 1873
145,125,	J. P. Raymond	Dec. 2, 1873
146,372,	W. Webster	Jan. 13, 1874
146,773,	R. W. Murphy	Jan. 27, 1874
146,774,	M. Murphy	Jan. 27, 1874
147,998,	C. B. Stilwell	Feb. 24, 1874
148,280,	C. G. Biedinger	March 10, 1874
151,258,	W. F. West	May 26, 1874
151,862,	G. Dunham	June 9, 1874

STEREOTYPING AND STEREOTYPERS' MACHINERY.*

Stereotype Metal.—The alloy for stereotype plates is composed of the same materials as ordinary type-metal. An alloy composed of 500 lead, 300 tin, and 225 cadmium, has, on account of its hardness, been proposed for stereotype-plates and backing for electrotypes.

Stereotype Planing and Sawing Machine.—(Fig 1.)—A machine for roughly planing the backs of stereotype-plates

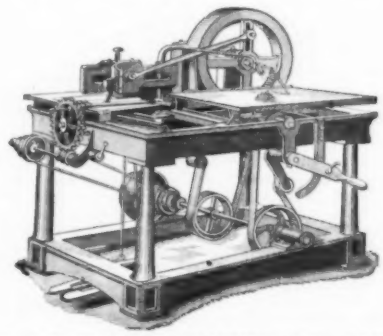


FIG. 1.—STEREOTYPE PLANING AND SAWING MACHINE.

previous to submitting them to the action of the shaving machine.

The plate is laid face downward on a table, which is advanced by a worm and worm-wheel, and, as it passes beneath two rollers which hold it firmly down, the back is traversed by a tool similar to the ordinary lathe-cutter, fixed in a head which is reciprocated by pitman connection with a fly-wheel. The tool cuts only in one direction; the carriage has a quick return motion. A circular saw and table at the other end of the machine are used for dressing off the edges of the plates.

Stereotype Press.—(Fig. 2.)—A small press for use in the clay process. *a* is the bed; *b* is the tympan, which may be

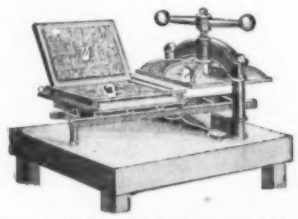


FIG. 2.—PRESS FOR STEREOTYPE MOULDING.
(CLAY PROCESS.)

large enough to cover the form, or consist only of hinges and clamps for holding a metallic plate; *c* is the platen.

Stereotype Routing Machine.—A machine for deepening the blank spaces in stereotype and electrotype plates. A very rapidly rotating cutter, driven by belting, is employed. It

FIG. 3.—STEREOTYPE ROUTING MACHINE.

is inserted in a holder upon a jointed lever, affording means of applying it at any part of the plate. A spring rest prevents the tool from touching the plate until pressed down by the operator.

Stereotype Saw.—A circular saw used for trimming the edges of stereotype plates. It is mounted on a stand having a table, on which the plate is laid and advanced by hand to the Hoe saw, which is driven by belt and pulley connection with the other machinery, or with a treadle.

Stereotype Saw-table.—A table provided with a circular saw operated by a treadle, used for trimming the edges of

* From Knight's "Mechanical Dictionary," Hurd & Houghton, New York.

stereotype plates. An adjustable gauge on the upper part of the table serves as a guide in presenting the plate to the saw. A pane, *a*, of glass, held by a crooked arm over the table, enables the operator to view the work without being struck by the flying particles of metal. At one end of the saw-mandrel is a cutter-head, with a sliding table for squaring up metallic blocks, etc.

FIG. 4.—STEREOTYPE SAW.

Stereotype Shaving Machine.—A machine for planing the backs of stereotype-plates. The plate is laid face downward on a traveling-bed, and is held by a ledge while it is drawn forward under a stationary knife, which takes off a shaving

FIG. 5.—STEREOTYPE SAW TABLE.

of the requisite thickness. Motion is imparted to the bed by turning the spoke levers, which turn a pinion gearing with a rack.

Stereotype Shooting-board.—The shooting-board used in stereotyping is a cast-iron plate, *d*, with a planed upper surface, having ledges for holding a stereotype plate firm while

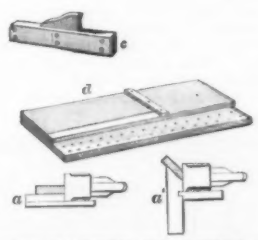


FIG. 6.—STEREOTYPE SHOOTING BOARD.

its edges are dressed off with a side-plane, *c*. The lower figures, *a a*, show the positions of the stereotype plates when *squaring* or *beveling* the edges.

Stereotyping.—The art of making solid plates forming an exact facsimile of the page of type as set up by the compositor, and from which impressions are taken in the usual manner.

The *plaster process* was invented by William Ged, a goldsmith of Edinburgh, who was employed by the University of Oxford in 1731 to manufacture plates for Bibles and prayer-books. These were injured by the jealous workmen of that day, and were thrown aside.

In 1698, J. Van der Mey, in Holland, had printed a quarto Bible and some other books from pages of type soldered together at the back, but this was not true stereotyping.

About 1779, Van der Mey's process was revived by Dr. Alex. Tilloch, of Glasgow, but it still does not seem to have come into general use, as we hear little of it until it was taken up by the French printers.

Carey's method of stereotyping, France, 1793, was as follows: the form was attached to a block suspended face downward from a beam, and was suddenly allowed to fall upon a surface of hot lead, just in the act of solidifying. The matrix thus obtained was used in a similar manner to obtain a relief cast or *cameo* impression, by dropping upon another surface of hot lead.

Didot (France) modified the plan by casting his types with a harder alloy, consisting of lead 30, antimony 30, tin 30, copper 10, and a form of such type was pressed by a fly-press into a surface of pure lead.

The matrix thus obtained was attached to the hammer of a stamping-press, on the bed of which was a paper-frame inclosing type-metal in a state of fusion. When on the point of setting, the metal was rolled up into a mass, and the matrix of the page brought down upon it, flattening it out and giving a stereotype-plate suitable for printing. This plan was adopted in Didot's edition of 200 volumes.

Herhan's plan (French) was to set up the form in copper matrixes, intaglio, and take a casting in type-metal therefrom, procuring a cameo impression at one operation.

"The invention of solid types by the Parisian printers, Didot and Herhan, is thought a great improvement. These types, instead of being detached characters, like the commoh, form a solid mass for each page, which, being incapable of derangement, fixes for ever the purity of the text. A great saving of paper results, as it is not necessary to take off a greater number of impressions than are wanted at one time."—*Monthly Magazine*, January, 1799.

Ged's process was substantially the "plaster" process as used at the present day.

In this the type is set up in the usual way, except that shoulder-high *spaces* and *quadrats* are employed. The face of the form is thinly and evenly oiled with a brush, and it is surrounded by a rectangular frame termed a *flask*. Plaster of Paris mixed with water is then poured upon it, form-

FIG 7.—DIPPING PAN.

ing a mould corresponding to the face of the form. When this has sufficiently hardened, it is withdrawn by turning screws at the four corners of the flask, and it is afterward dried in an oven until all the moisture is driven off. The mould is then placed face downward upon a cast-iron plate, termed a *floating-plate*, and this is placed within a cast-iron tray, termed a *dipping-pan*, having a lid which is secured by means of a screw, and the whole is heated to about 400° Fahr., lifted by means of a crane suspended over a pot of molten metal, and gently lowered into the bath, where it is immersed to near the bottom, the metal flowing in and filling

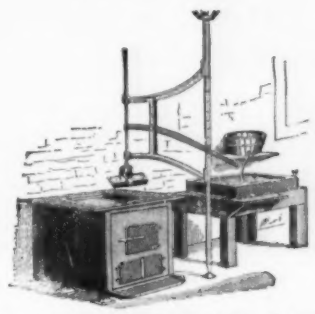


FIG. 8.—STEREOTYPING APPARATUS.

up all the cavities in the face of the mould, though forming but a thin film on the back. After remaining 8 or 10 minutes in the metal the arrangement is lifted therefrom by the crane, swung over the cooling trough, and lowered upon a stone, so that the bottom part just comes in contact with the water; the face part is first cooled, and as shrinkage takes place it is filled up from behind. The pan is then opened, the mould separated from the cast by beating with a mallet, and the face examined to see if there are any irremediable defects; if not, the plate is planed on the back and dressed on the sides, to adapt it to the *block* on which it is placed for printing. The planing is effected by the machine above described, worked in a manner analogous to the engraver's plate printing-press, and the sides are squared by the *stereotype-saw*, and beveled by a plane while held on the shooting-board. Any flat shallow place into which the paper might be pressed and gather ink are worked deeper by the *stereotype routing machine*.

Stereotyping was introduced into the United States by David Bruce, of New York, in 1813; the first work cast in America was the New Testament, in bourgeois, in 1814.

The curving of stereotype-plates to adapt them to a cylinder printing-press was patented in England by Cowper in 1815; but was not practiced with any great success until of late years, when it was introduced upon daily newspapers in connection with the revolving type-cylinder of Hoe.

Clay, or Clay-and-Plaster Process.—The form is locked up with *high furniture* and *slugs*, and placed on the bed, *a*, of the press shown in Fig. 2. The face of the type is brushed over with benzine or naphtha, and covered with a cloth or paper.

A detachable plate is hinged like a tympan to the press bed. On the face of this plate a mixture of equal parts ground potter's clay and gypsum, moistened to the consistency of mortar, is spread with a trowel to the depth of about ¼ of an inch.

The tympan is now turned down on the form, the bed runs under the platen, and a partial impression is taken, sufficient to give the general outline of the *form* to the clay coating. The press is then opened, the cloth removed, and also any surplus material which has been thrown up by the

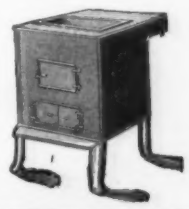


FIG. 9.—STEREOTYPING FURNACE AND METAL POT.

first pressure, and would be likely to bind. The press is again closed, and complete impression taken, embedding the type in the plastic material to the desired extent.

The metallic plate carrying this mould is then removed from the press, and hardened by drying. When dry, it is set afloat face upward in a vat of melted type metal, as the most convenient means of bringing mould and metal to a uniform temperature.

A wire, bent like a horseshoe, is then put on the plate around three sides of the mould. The wire is somewhat thicker than a completed stereotype-plate. A second sheet of metal is clamped over the wire, as in a moulder's flask. The plate is then put in a rack or trough with its open edge upward, and the metal poured in. The cooling may be hastened by turning water on the outside of the flask. When the casting is removed the clay adheres to the face of the plate, and is removed by washing. The plate is then planed, trimmed, and dressed up for use. Curved plates for cylinders are made from a flat form by using a sheet of spring steel of the desired curvature, for a base plate, which is spread flat on the tympan and the plastic material is applied to what is to be the concave side. After the impression is taken the sheet is released, and resumes its normal curvature, bending the plastic mould with it. The face of the plate is of course somewhat distorted, the stereotype appearing as if taken from type a little more condensed one way than that actually employed in the form.

The *papier maché* process was invented by Wilson, in Scotland, in 1823. It is a very expeditious process, and is generally used on the daily papers of large circulation. A paper matrix is formed by spreading paste over a sheet of moderately thick unsized paper and covering it with successive sheets of tissue-paper, each carefully patted down smooth, and the pack then saturated.

The face of the type is oiled, the face of the paper treated with powdered French chalk and laid upon the type. A linen rag is wetted, wrung out, laid over the paper, and then the matrix dabbed by a beating-brush from the back, so as to drive the soft paper into all the interstices between the letters of the form. Remove the cloth, lay a re-enforce sheet of damp matrix paper upon the back of the matrix, and beat it again without the cloth, to perfect the impression and establish a junction. For large establishments a matrix-rolling machine is used. Put a double thickness of blankets upon the matrix, place form and matrix in a press, and

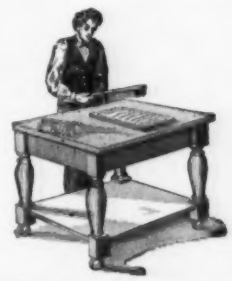


FIG. 10.—BEATING TABLE.—(PAPIER-MACHE PROCESS.)

screw down tight. The lighted gas heats the press and the form, and dries the paper matrix. The press is unscrewed, the matrix removed, its edges pared, and is warmed on the moulding-press. The matrix is then placed in the previously heated iron casting-mould; a casting-gauge to determine the thickness of the stereotype is placed round three sides of the matrix, the other side being left open for a gate, at which the molten metal is poured in. When the metal is *set*, the mould is opened and the matrix removed. The plate is then trimmed and otherwise prepared in the usual manner.

Mr. Muir, of Glasgow, employed gutta-percha slabs for forming stereotype-moulds; the process consisted simply in applying the slab while hot to the form of type, and subjecting it for some 15 minutes to the action of a screw-press. The face of the mould being afterward black-leaded, an electrotype cast was taken. He also made stereotype plates from the same substance, the mould being obtained in the above manner, and the plate formed under pressure while heated.

FIG. 11.—STEREOTYPE MOULD DRYING PRESS. (PAPER PROCESS.)

Iron electrotypes were made by Klein, a Russian, and the process patented in the United States, September 29, 1868. See SCIENTIFIC AMERICAN November 18 and November 27, 1868.

In Joyce's process for obtaining plates in relief from intaglio moulds, patented July 14, 1874, a smooth plate of iron, such as is used in the clay process of stereotyping, is covered with a thin layer of suitable composition, ordinary thin clay and pulverized plaster. When dry, the design or writing is cut into the composition by means of pointed or sharp-edged graving-tools, so as to expose the face of the plate at those parts which are to show black in the print. The nature of the material enables a skilled draughtsman to cut his design in the matrix without the necessity of previously making a drawing on the surface, or of transferring from a drawing on paper. In case a design is to be copied, the paper is laid directly on the face of the mould, and the lines traced through with a blunt-pointed instrument, the composition being sufficiently yielding to receive and retain the impression; its texture also admits of erasures and corrections being made. When the design is finished, the plate and matrix are heated, and a cast is made with stereotype metal in the manner usual in the clay process, a somewhat higher temperature, however, being required to insure the perfection of the face which is formed by the mould-plate. The stereotype-plate, thus formed, is trimmed, planed, and finished, in the usual way, the depressions being deepened by routing, if necessary.

This process enables cuts, maps, autographic or facsimile writings, etc., to be produced in a form suitable for working on an ordinary letter-press in a very simple and expeditious manner.

[Continued from SUPPLEMENT No. 190.]

[Translated from La Nature.]

THE BEGINNINGS OF LIFE.—IV.

By PROF. EDMOND PERRIER.

BEINGS INTERMEDIATE BETWEEN ANIMALS AND PLANTS.

THE flagellate infusoria are the monads of old authors. We know at the present day a great number of forms which swarm in all parts of the globe. Some are provided with

FIG. 1.—FLAGELLATE INFUSORIA.

1. *Astasia hæmatodes*, Ehrb. 2. *Phacus longicauda*, Ehrb. 3. *Euglena deses*, Ehrb. CILIATE INFUSORIA. 4. *Stentor polymorphus*, Ehrb.

a single flagellum or vibratile lash, others possess two; and the majority exhibit a contractile vesicle that is seen to beat like a heart, but more slowly. It is a small transparent pocket forming a protuberance on the side of the body (Fig. 2, No. 1). This protuberance slowly swells, then its contents are expelled, and the vesicle becomes for the moment invisible; but it is not long, however, before it reappears, and the phenomenon is repeated as long as the animal lives. The length of each beat appears to be sufficiently constant to serve as a specific character. Many rhizopods, and even a certain number of zoospores, possess, like the flagellate infusoria, a contractile vesicle. This vesicle can scarcely be considered as an organ of circulation, but is rather an excretory apparatus. The form and color of the flagellate infusoria are extremely variable. The Phacus (Fig. 1, No. 2) is flattened and leaf-shaped; Euglena (Fig. 1, No. 3) is elongated rod-shaped; the Astasiæ are

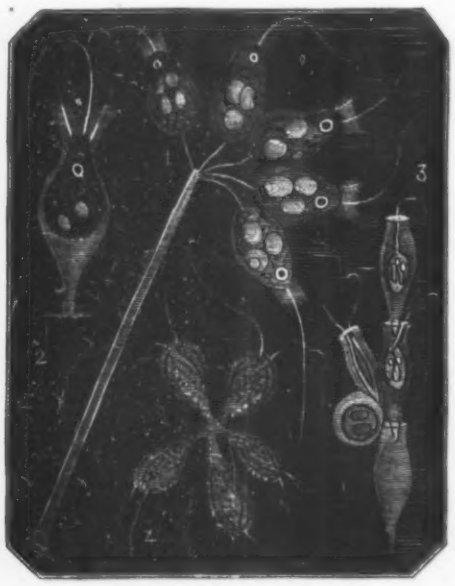


FIG. 2.—FLAGELLATE INFUSORIA.

1. *Codosiga botrytis*, Ehrb. The two individuals to the left show upon their side their swollen contractile vesicle. 2. *Salpingœca Clarkii*, Bütschli. 3. *Dinobryon sertularia*, Ehrb. 4. *Uvella virescens*, Ehrb.

ovoid and may be considered as cells of volvox, which always live independently of each other and do not associate together in colonies like the stephanosphæræ, the gonia, and the volvoces properly so called.

Certain species are of a green color, and may be considered as unicellular plants, and the more so since the astasiæ are involved for a certain time in an envelope of cellulose. Others, like euglena sanguinea and astasia hæmatodes (Fig. 1, No. 1), exhibit a bright red color. Several organisms of the latter group contribute to the red color that rain and snow sometimes exhibit, and which is attributed to blood by superstitious people. Monas prodigiosa, also of a red color, is quite frequently developed on amylaceous substances; and has been observed on bread and the consecrated wafers used in Roman Catholic churches. Occasion has been taken in such cases to make believe that such bread and wafers emitted blood.

Other flagellate infusoria are entirely deprived of coloring matter. If it were permitted to class those of which we have just spoken, with algæ, the colorless ones would be included with fungi; but, on the other hand, nothing can prevent us from classing them among animals, and we shall see, in fact, that they are very closely connected with certain constituent elements of the sponges.

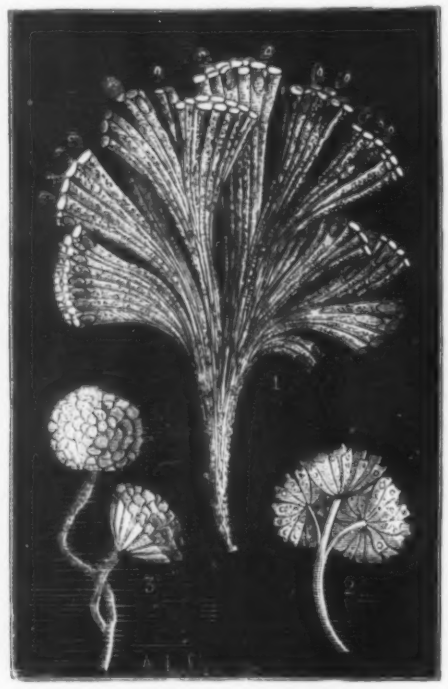


FIG. 3.—FLAGELLATE INFUSORIA.

1. *Rhipidodendron splendidum*, Stein. 2. *Cephalothamnium Cyclopum*, Stein. 3. *Anthophysa vegetans*, Stein.

Some of these organisms are remarkable for the presence of a sort of membranous collar at the base of their flagellum, in the shape of a funnel. This is one of the characters of the genus salpingœca. Different species of the latter genus secrete a membranous urn-shaped case, in which they dwell; salpingœca Clarkii, for instance (Fig. 2, No. 2). A certain number of infusoria quite often associate together in colonies. Cells resembling salpingœca, to the number of eight to twelve, embrace one another in a straight line, and form the genus conodesmus of Stein. The anthophysæ and cephalothamnia (Fig. 3, No. 2) form large spherical capitula

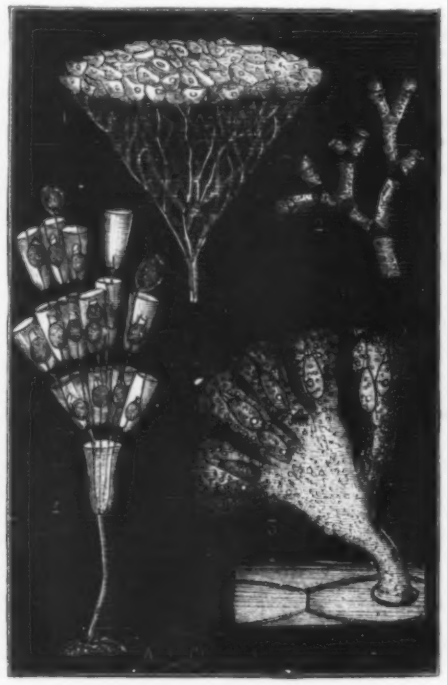


FIG. 4.—FLAGELLATE INFUSORIA.

1. *Dendromonas virgaria*, Weise. 2. *Cladomonas fruticulosa*, Stein. 3. *Phalansterium digitatum*, Stein. 4. *Poteriodendron petiolatum*, Stein.

at the extremity of more or less ramified and flexuous stems; the uvellæ (Fig. 2, No. 4) which are green in color, and the codosigæ (Fig. 2, No. 1) which are colorless, are arranged in bouquets at the summit of a long peduncle. The dinobrya (Fig. 2, No. 3), each individual of which possesses its own case, form ramified, arborescent colonies of great elegance

Several species form colonies that are relatively extensive and very remarkable, some from the regular arrangement of the individuals which compose them, others from the importance of the secondary parts secreted by the infusoria to shelter them. For instance, the anthophysæ, codosigæ, and poteriodendra (Fig. 4, No. 4) are pedunculated; but here every individual has its own peduncle, and these colonies, so wonderful by reason of their perfect symmetry, are formed by a series of successive bifurcations. The peduncles of the dendromonas (Fig. 4, No. 1) are arranged in such a way as to bring all the individuals on the same plane, and to thus form a kind of corymb very elegant in appearance. A transparent, membranous urn, scarcely visible, and a peduncle of greater or less length, are the only parts that complicate the colonies that we have just studied; the

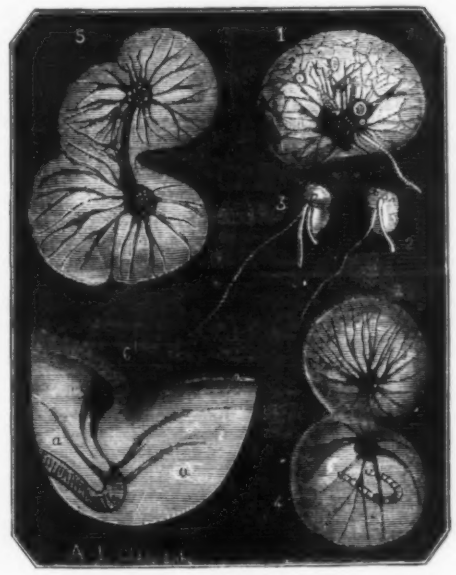


FIG. 5.—NOCTILUCÆ.

1. *Noctiluca miliaris*. 2 and 3. Flagellate spores of the same. 4 and 5. Different phases of the union of noctilucæ. 6. Portion of noctiluca showing the groove, and the flagella at the base of the tentacle.

flagellate cell is always the most extensive element in them.

In the genus rhipidodendron (Fig. 3, No. 1) the animal dwells in a tube more or less curved, thick, granular, and not very transparent, and which increases constantly in length, and becomes so long eventually that its proprietor inhabits only an insignificant part of its extent. Several of these tubes are joined one with another so as to form most graceful tufts. The cladomonas (Fig. 4, No. 2) construct analogous tubes, but they are arranged in dichotomous ramifications. In the genus phalansterium (Fig. 4, No. 3) the habitations assume a still greater importance, and are fixed to the summits of great gelatinous clubs, which are arranged more or less compactly in an arborescent form. (A large number of other forms of these animals may be found figured and described in the SCIENTIFIC AMERICAN SUPPLEMENT for June 1, 1878, page 2004.)

Thus, not only are the flagellate infusoria fitted to live in common, and to become grouped in colonies, but they can also, without losing anything of their primitive character, complicate these colonies by extensive accessory parts, ap-

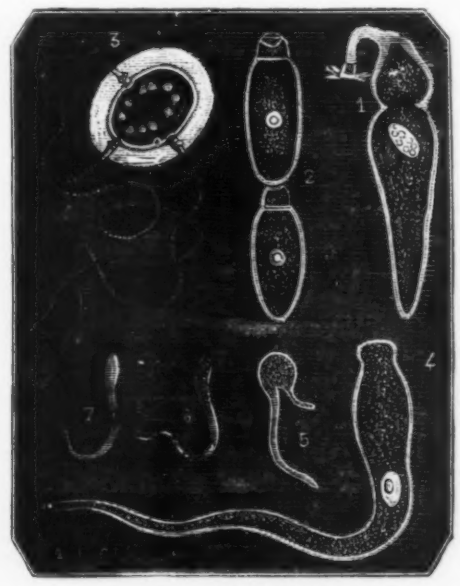


FIG. 6.—GREGARINIDA.

1. *Hoplorhynchus oligacanthus*, A. Schneider. 2. *Clepsidrina blattarum*, Schneider. 3. Cyst of the same species emitting its spores. 4, 5, 6, 7. Different phases of the development of the *Gregarina gigantea*, Van Beneden, of the lobster.

parently living, but which are scarcely anything more than the result of a sort of exudation of the animal. We gradually pass from such simple forms as the euglenæ or the salpingœcæ to true cities of infusoria—cities built in common, and where each individual preserves its independence to the same degree that any citizen of a city may with respect to his fellow-citizens. And just as in a city the buildings are infinitely more extensive than the inhabitants, so in these colonies of flagellate infusoria we see the habitation forming

a mass infinitely larger than the total mass of beings to which it owes its origin.

It sometimes happens that the individuals composing these colonies become detached and go to found colonies elsewhere. To see this phenomenon take place it is only necessary to observe a rhipidodendron for some time. So every colony contains quite a large number of tubes that have been abandoned by their inhabitants; but when the infusoria are all still there, a marvelous activity reigns in the little world. The surrounding water, constantly lashed by the vibratile flagella, circulates rapidly around it, bringing with it the air necessary for respiration, and the alimentary matters which each of the infusoria seizes as they come along.

The colonies of anthophysa, codosiga, uvella, dinobryon, etc., are evidently formed of elements which correspond exactly with those which constitute a volvox, a stephanosphæra, or a magosphæra. Between these two kinds of colonies, however, there is an important difference: in those of the first species, each of the individuals composing it preserves, as we have said, its complete personality; it only contracts a union, and that a mechanical one, with its neighbors, and in a physiological point of view is entirely independent of the latter. With the volvoces and their allies or with the magosphæræ, it is entirely different. Here the individual appears to be an assemblage of ciliate or flagellate cells that we have described above; and the component cells are only secondary, subordinate individualities, co-operating together to maintain the higher individuality of which they form a part. Moreover, all these cells are exactly like one another, play exactly the same part and behave exactly in the same way. All contain within themselves something like the effigy of the complex individual of which they form a part; and all are fitted for reproducing it with all the peculiarities that it exhibits; and, in this group, reproduction consists essentially, in fact, in this, that each of the cells composing an individual isolates itself and afterwards becomes divided in such a way as to re-establish an organism like the one from which it was detached.

Sometimes the organism of the flagellate infusoria becomes especially complicated, without rising, however, above the value of a simple cell. In the genus ceratium (an individual of which, captured by a protomyxa, is represented in Fig. 4 of our first article), and also in the genus peridinium, the body is covered with a curiously carved carapace, the clefts of which allow small bands of vibratile cilia to appear coexistent with the flagella. The peridinia are phosphorescent; and they are sometimes developed in such large numbers that, notwithstanding their microscopic size, they render the sea luminous over a vast extent. A phosphorescence due to peridinia exclusively was observed by Ehrenberg in the Sea of Naples in the year 1869.

There is an organism, however, pretty closely related to the infusoria, but of much smaller size—the noctiluca miliaris—that most usually produces the phenomenon of phosphorescence of the sea in our latitudes. Its form is spherical; a groove of certain depth extends along one of its meridians, and from the bottom of this furrow proceeds a movable tentacle which has been compared to the flagellum of the infusoria. At the foot of this tentacle is found a sort of lip furnished with vibratile cilia, and bearing on its lower surface two flagella (Fig. 5, Nos. 1 and 6). The wall of the noctiluca's body is tough, membranaceous, and forms a vesicle, in the interior of which is found a nucleus from whence radiates a protoplasmic network always in motion. We might compare these strange beings to radiolarians, all of whose protoplasm is contained in the interior of the central vesicle.

The noctilucæ have been carefully studied by Messrs. Quatrefages, Busch, Huxley, Webb, and Brightwell. Messrs. Cienkowski and Charles Robin have studied their mode of reproduction: this takes place either by simple division or by the formation of zoospores in all respects like those of the radiolarians (Fig. 5, Nos. 2 and 3). Every noctiluca furnishes (according to the time at which segmentation is arrested) from 256 to 512 zoospores. This fecundity explains how the number of individuals is sometimes great enough to change the color of the ocean. Two noctilucæ often become joined to one another at the period when the zoospores are produced, and this sort of coupling appears to hasten the operation (Fig. 5, Nos. 4 and 5), but the true nature and importance of this junction is as yet very obscure.

These phenomena of reproduction show that the noctilucæ are beings much higher in the scale of life than the flagellate infusoria properly so called. Should they be considered as animals? Evidently they do not exhibit characters proper to the animal kingdom much more than do the myxomycetous fungi; yet they are protista, equivalent to a single cell, but the cell has here assumed a considerable size and has singularly departed from the typical form found in higher organisms. If now, recapitulating the facts that we have just set forth, we endeavor to place in a clear light the affinities by which the protista are united either to each other or to plants and to animals properly so called, we can sketch the following picture of their evolution.

At the lowest step of the scale, immediately above the moners, come protoplasmic beings whose homogeneity is disturbed only by the presence of a nucleus and nucleolus. The protoplasm is free, without an enveloping membrane, and its contour may assume all possible forms. Such are the amœbæ, which are reproduced by a simple division into two halves, and in which division the nucleus and nucleolus take part as well as the protoplasm.

The first step in advance is made when this protoplasm becomes fitted for secreting a membranous envelope, within which it becomes divided so as to give rise to zoospores in greater or less number. If the envelope is of an albuminoid nature, the organism that produced it approaches the animal kingdom; if, on the contrary, it is of the nature of cellulose, the organism tends toward the vegetable kingdom. Albuminoid substances are always more or less flexible; cellulose is firm. It follows from this that the movements of the protoplasm in the first case will be observable externally, but in the second case they will cease to be apparent. This is why all animals are capable of moving, while the great majority of plants are immovable during their whole lifetime. The tendency toward the vegetable kingdom is always shown if starch granules are deposited in the protoplasm, or a green or red coloring matter, as we observe in many of the flagellate infusoria. If the coloring matter does not make its appearance, we are at a loss to determine, and we can just as well refer the forms that are deprived of it to the animal kingdom, as to the branch of the vegetable kingdom represented by the fungi. The myxomycetes are the extreme limit of the passage from the protista, properly so called, to the fungi. On the contrary, the euglenæ, the astasiæ, and other colored flagellate infusoria, lead us directly to the green or red algæ, and, through these, to the higher and better characterized plants. As for the passage to animals, it is established in so natural a way that it requires quite an effort of mind to refer the beings that we have just described to the vegetable kingdom. The first impulse is to make animals of them, and, in fact, the first truly animal forms of the organic world are infinitely nearer the protista than the first truly plant forms. Protoplasm, as paradoxical as the statement may seem, must have become less modified in order to produce the first animals than to produce the first plants. The former have, perhaps, preceded the latter in the order of appearance.

The gregarinida, discovered by Leon Dufour in 1826, show us, in their turn, how the transformation of moners into cellular organisms can be effected, that is, into organisms whose protoplasm contains a nucleus and is surrounded by a membrane. The adult gregarinida are composed of one or two cells, the anterior of which is at times surmounted by a caducous appendage serving perhaps as an organ of attachment (Fig. 6, No. 1); and all occur as parasites within the bodies of other animals, more especially those belonging to the sub-kingdom annulosa. They are found in small masses in the intestines of a large number of insects, in those of moles, in the body cavities of certain worms, and in the reproductive organs of lumbrici. They have been carefully studied by Lieberkühn, Edward Van Beneden, and Aimé Schneider. At a certain period of their existence they become surrounded with a firm cyst; and sometimes two gregarinæ come into contact and a cyst or capsule soon forms around them both. In either case the contents of the cyst soon divide and become transformed into a multitude of peculiar bodies which have, from their form, received the name of pseudo-naviculæ. Long tubes soon develop at the surface of the cyst (Fig. 6, No. 3), and through these the pseudo-naviculæ are set at liberty. Under the influence of moisture, the external envelope of the latter breaks and gives rise to amœbiform bodies, which at length develop themselves into young gregarinidæ. Van Beneden has studied the development of these amœbiform bodies in a gigantic species (gregarina gigantea) inhabiting the intestine of the lobster. The protoplasmic mass, after moving about for some time, at length has no more than two pseudopodia: one of these is immovable and rigid, and the other flexible and constantly moving in a worm-like manner. The latter soon becomes detached, and then closely resembles a small filaria. But the closest examination does not reveal the least trace of organs: it is a true moner—the pseudo-filaria of Beneden.

Soon, however, there appears in its median region a small, clear spot which increases by degrees. It seems as if a sort of departure was being made in the protoplasmic mass, as if a part, with greater consistency and more refractive, was being precipitated and condensed in the central region. This is the origin of the nucleus, the mode of formation of which would appear to be almost mechanical. The moner deprived of a nucleus has become a cell. The cell to become complete has only to surround itself with a membrane. A simple physical modification of the outermost layer of the protoplasm suffices to produce this phenomenon, and the young gregarina thus finds itself completed. The fact that the pseudo-naviculæ form a part of the cycle of evolution of the gregarinida has been disputed, since naturalists see in them only simple parasites of the encysted gregarinida; but this in no way puts in question the part of the embryonic history of the gregarinida which connects them, through a phase in which they are true moners, with the protoplasmic mass that produces the pseudo-filariæ. Thus the gradual passage of animals and plants to moners is established in the completest manner; and we see the moners transforming themselves into cellular organisms. The latter live at first in a state of simple cells, capable of successively taking on several forms; but soon they acquire a new faculty, that of becoming associated. The cells, produced one from another, dwell united into true families, the members of which, from the very first, preserve a reciprocal independence, as we see in the dinobrya, anthrophysæ, codosigæ, etc. Often, as in the rhipidodendra and the phalansteria, the union of the individuals seems to take place only through the intervention of secondary parts, the mass of which is considerable, and which complicates the colony by an important element; but the members of the family may by a new step in advance contract a closer union, and then form true multicellular individuals, composed of cells entirely like one another, as in volvox and allied algæ, or in magosphæra. All the cells composing this new individuality are fitted to reproduce it, contain within themselves the law of its development, and transmit it to their descendants.

It is a necessary consequence of this fact that the reproduction of cells never takes place except by a simple division. The parts which proceed from this division are forcedly identical with the mother cell, and consequently possess all of its chemical or physiological properties, including those which determine its mode of evolution. This is the reason, entirely mechanical, of the law of heredity, by virtue of which every organism transmits its inherited or acquired characters to its descendants. Heredity is the inelectable consequence of the mode of reproduction of the constituent elements of living beings.

Societies once formed—and this takes place at an early period, since we know of social moners—the division of physiological labor supervenes, just as in societies of human beings. The elements forming a society or colony are at first all like one another (as in the colonies that have been considered in this article), but soon unlike elements become associated, these coming, however, from the other, and representing the successive phases that may be assumed by certain unicellular beings having different roles to perform in the association, each living on its own account, but also accomplishing certain functions for the common good of all. Hence arises a greater variety: the organisms, instead of being comparable to an association of snops of workmen each working for himself, seem to be vast factories where the power of production is rapidly developed in considerable magnitude. This is a fundamental phenomenon that is presented in the history of the sponges.

THE BROOKLYN TREATMENT OF DIPHTHERIA.

By PAUL H. KRETZSCHMAR, M.D., Brooklyn, N. Y., Assistant to the Chair of "Practice," Long Island College Hospital.

THE list of remedial agents employed in the treatment of diphtheria is an exceptionally long one. Apomorphia, sulphate of copper, muriated tincture of iron, guaiacum, mild chloride of mercury, biniodide of mercury, black oxide of mercury in the form of vapors, ipecacuanha, chlorate of potash, iodide of potassium, sulphate of quinine, salicylate of soda, salicylic acid, carbolic acid, sulpho-carbolate of sodium, flowers of sulphur, are only a part of the remedies which have been or are to-day employed in the constitutional treatment of the disease. Just as long a list of drugs could be made up by naming those which are recommended for topical application. If we find numerous remedies in use against any disease, that fact may be considered as evidence that the therapie in such a case is not well settled. Several of the remedies mentioned have been at one time or another praised highly by enthusiastic writers as "specifics." Yet the mortality of diphtheria is indeed enormous; Albu (*Journal für Kinder-Krankheiten*, liii., p. 164) states it to be 47 per cent.; according to other writers it varies between 20 per cent. and 50 per cent.

To speak briefly of the merits of "alcohol" in the treatment of diphtheria, and to report my experience in thirty cases treated by alcohol, is the object of this paper.

The treatment of uræmic convulsions, and especially that of puerperal eclampsia by large doses of veratrum viride, has gained considerable reputation as the "*Brooklyn treatment.*" The same name should be applied to the alcoholic treatment of diphtheria, because its first advocate was a physician of this city. As early as 1863 has Dr. E. N. Chapman, in the *Boston Medical and Surgical Journal*, published his opinion on this subject. He has defended his assertions since that time on several occasions, and has lately published a valuable little work on the subject.

The reappearance of diphtheria during the past winter in an epidemic form, and its undiminished mortality under the so-called "recognized" forms of treatment, should draw the attention of the profession to the existing antagonism of alcohol and diphtheria.

Dr. Chapman, in his first article in the *Boston Medical and Surgical Journal*, reported nineteen recoveries in twenty consecutive cases; he gave further evidence of the value of the alcoholic treatment of diphtheria at a meeting of the Kings County Medical Society early in 1874, and in October, 1877, he read a paper before the same society, stating that during the period of more than three years he had treated eighty-five cases of diphtheria by large doses of alcohol with the most gratifying results. Of the eighty-five cases reported, eighty-four made a splendid recovery and one died. In the little work, "The Antagonism of Diphtheria and Alcohol," the doctor publishes his observations up to the 15th of May, 1878, and he reports forty more cases, with thirty-nine recoveries and one death. One hundred and twenty-five cases of diphtheria have been treated with alcohol—*and of those but two died.* If compared with the usual mortality of the disease, the statistics given are so remarkable as almost to stagger belief, more especially as the doctor has not even lost a case of croup during the period of his observation.

A natural feeling of doubt may come over almost everybody about the correctness of the diagnosis; but Dr. Chapman's ability and his excellent reputation should be sufficient evidence that the reported cases were "genuine" and not "homœopathic" cases of diphtheria.

Of late several practitioners of this city have employed the alcoholic treatment, and it has yielded results emphatically confirmatory of Dr. Chapman's. Having tried the "Brooklyn treatment" in thirty cases, I can only confirm what Dr. Chapman says about its great efficiency and value.

Shortly after the doctor read his paper before the Kings County Medical Society in 1877, I treated for the first time a case of diphtheria with large doses of alcohol. The patient made a good recovery. I have since treated thirty cases of diphtheria by this method, many of them of the most severe variety, and a number of them complicated by scarlet fever, and I only lost four. Twenty-six recoveries and four deaths is an excellent success; if added to the cases reported by Dr. Chapman, our statistics will show an aggregate of one hundred and fifty-five cases treated with large doses of alcohol. Of these one hundred and forty-nine recovered and six died—*a mortality of about 4 per cent.* If clinical experience can settle therapeutical questions, the alcoholic treatment of diphtheria must be recognized as one of the most powerful means to diminish the mortality of the disease. Whatever the true pathology of diphtheria may be—whether the local affection is only a symptom of a specific condition of blood poisoning, or whether the disease should be regarded as a contagious infectious one which commences as a local difficulty, and which may either continue and remain such, or may lead secondarily to a constitutional affection, a large clinical experience shows that there is no form of treatment more effectual than the administration of large doses of alcohol. In cases of diphtheritic poisoning alcohol does not act as a stimulant; it induces none of its ordinary effects; intoxication has never been observed, while enormous doses have been administered to young children. The remedy should not be employed as in a variety of other diseases, to relieve or prevent great prostration, but simply for *its specification as an antidote to the diphtheritic poison.* Not only as an antidote, but also as a *preventive* of diphtheria, has alcohol proven to be of great value; if administered early and in sufficient doses, its prophylactic properties can easily be demonstrated. And even to prevent or cut short any of the sequelæ of diphtheria, there is no remedy as reliable as alcohol.

In most of Dr. Chapman's cases quinine had been administered in addition to the alcohol; in twelve cases of mine, all of which recovered, alcohol alone was employed. The effect seemed to be almost as decided and quick without as with quinine. The children often refused the medicine on account of the taste of quinine; lately I have always used quinia by inunction and given the alcohol separately. I have in cases of diphtheria, but oftener in cases of acute catarrhal pneumonia, produced cinchonism by the frequent use of an ointment made of

Quiniæ sulph.	℥ ss.
Chloroformi	ʒ ss.
Bals. Peru.	ʒ ss.
Adipis	ʒ vj.
M.	

For the administration of the alcohol the following formula has generally been employed:

Spts. vini Gallic., or Spts. frumenti	℥ ijss.
Glycerini opt,	
Syr. simplic	aa ℥ ss.
Aquæ menth. pip.	q.s. ad ℥ iv.
M.	

To children under two years ʒ j. every hour, from two to three years ʒ jss., from three to five years ʒ ij., from five to eight years from ʒ ijss. to ℥ ss., every hour.

In a few very severe cases champagne has been used. Great importance has always been attached to hygiene; cleanliness and fresh air have always been obtained first of all. Of course, whenever a direct cause for the development and propagation of the diphtheritic poison could be found great care has been taken to remove it. It was hardly ever left to the inspector from the Board of Health to examine the plumbing; the escape of sewer gas could be detected in about one-half of the cases reported.

Whether any good effect can be obtained from topical treatment will not be discussed. I have always employed a light astringent application, either in the form of a gargle or spray, or as a powder, to be blown on the diseased parts. Chlorate of potash, powdered alum, and tannic acid, either combined or otherwise, with the addition of a comparatively large quantity of carbolic acid, have been used. Of late Wyeth's tablets of chlorate of potash have been found to be a very convenient form for the administration of the salt. During the first twenty-four hours of an attack, little or no nourishment has generally been taken, but in all instances the first food given consisted of milk and limewater, with the addition of a few grains of salt. The experience gained in thirty cases strongly impresses the facts that, at least in cases of diphtheria, there is no kind of food which is so well borne by the stomach of the sick, as limewater and milk. No one can deny that this form of food introduces all the necessary elements of nutrition in the most exact proportions, as needed by the several tissues of the body. Iron, and especially the "Dialyzed Iron," has been employed during convalescence, and it has, in combination with some form of alcohol, either prevented or relieved the conditions of anæmia and loss of nerve power which are so apt to follow diphtheria.

A few cases may be cited:

Walter B., æt. 7, a rather delicate boy of healthy parents, attended school as usual during the forenoon of April 4th, '78. He had a very severe chill at about 11 A. M. and went to bed after coming home at noon. I saw the boy at 4 P.M. Temp. 105½. Pulse 134. Skin dry. Fauces coated with diphtheritic membrane. Great prostration. Ordered brandy in teaspoonful doses every hour; cold application to the head and a carbolated chlorate of potash gargle. At 11 P.M. patient delirious. Temp. 106¼. Pulse 140. Cold compresses continued and brandy increased to ʒ jss. every hour.

April 5th.—Patient had a very restless night, but at 10 A.M. he feels quite comfortable, with a temperature of 101½. Pulse 108. Diphtheritic exudation extending. 6 P.M. Difficulty in breathing marked. The child struggled for breath as in membranous croup; the administration of 3 grs. turpeth mineral each had the desired effect and caused free emesis. Treatment continued.

10 P.M.—Patient feels easier. Dyspnœa diminished. Temp. 102½. Treatment continued.

April 6th, 10 A.M.—Patient slept some. Temp. 101½. A copious purulent secretion, followed by disintegration of the membrane, took place. The pulse is yet very feeble, the boy very much prostrated. Under the "alcoholic treatment" the boy improved slowly and was discharged, free from any sequelæ, on April 22, '78.

Louis H., æt. 8, was taken sick with diphtheria in January, '78. The origin of this case could be traced to the presence of sewer-gas. Two other children and the parents escaped the disease by the exclusive use of alcohol and cinchonia, administered in the following way:

℞	Cinchon. sulph	ʒ j.
	Acid. sulph. arom	q.s.
	Spts. vini Gallic	♏ vij.
	Glycerini opt	ʒ j.

M. From a small teaspoonful to a tablespoonful given every two hours, according to the age.

In this case the false membrane covered from the outset almost the entire pharynx. It soon extended both into the nostrils and downward; the larynx became implicated to such an extent that I asked my friend Dr. Pilcher to be ready, at a moment's notice, to perform tracheotomy. Two teaspoonful doses of brandy, given every hour, day and night, did not seem to influence the circulation at all, it produced none of the common effects of alcohol, but it carried the little patient safely through a very severe attack of diphtheria. The fœtid discharge from the nose continued for about twelve days. No sequelæ.

Robert M., æt. 6.—A younger brother had died of diphtheria end of November. Saw the boy for the first time December 8th, and found him suffering from a severe attack of the disease. Temp. 103½. Severe headache; great prostration. The boy made a splendid recovery under the alcoholic treatment, and was discharged on Dec. 15th.

Five cases of scarlet fever and diphtheria in the same house.—About the middle of December I was called to see a little boy, John Rossee, 7 years of age, who had been ill for several days. The little patient presented a perfect picture of blood poisoning. Temp. 105. Pulse 140. Skin dry, having a dusky sodden look. The boy was exceedingly restless, throwing himself from one side of the bed to the other. The stomach had rejected everything during the last 24 hours. There was no diphtheritic membrane to be detected, but the fauces presented a diffusive deep colored redness bordering on bluishness. This condition, together with the grave constitutional symptoms, led me to diagnose "commencing diphtheria." The following morning, after a very restless and delirious night, the fauces, the tonsils, and parts of the roof of the mouth were covered with diphtheritic exudation. The cutaneous eruption of scarlatina also made its appearance. The patient was put on alcohol and quinine treatment, the following formula being used:

℞	Quin. sulph	gr. xvj.
	Acid sulph. arom	q.s.
	Spir. vini Gallic	ʒ jss.
	Syr. simplic	*ad* ʒ ij.

M. S. Teaspoonful every two hours.

During the next few days the boy was in an exceedingly low condition, and on the second morning it was thought best to give him, besides the mixture just referred to, two drachms of whisky every two hours. The great prostration and the high fever were the characteristics of this case. The local affection, although quite extensive in the beginning, was soon subdued.

Five days after the boy was taken sick, just at the time he commenced to improve, Clara, a girl of 12, began to complain of headache, nausea, restlessness, etc. The next morning she developed scarlatina without any sign of diphtheria. The treatment was the same as in the boy's case.

Three days later, the boy still improving, Emma, a bright little girl of 5, was taken sick. The disease was ushered in by several severe attacks of convulsions, each one lasting from 25 to 40 minutes. The signs of scarlatina appeared the following morning, and diphtheria in its most malignant form (laryngeal diphtheria) became developed soon afterwards. The child refused all food; medicine had to be forced on her. At that time the prescription had been taken to another pharmacist, who prepared the mixture according to the copy furnished by the first druggist, which read:

Quin. sulph. gr. xvj., acid. sulph. arom. q.s., spir. vin. Gall. ʒ jss., syr. simplic. *add.* ʒ ij. S. ʒ j. every 2 hours. The carelessness of the druggist deprived the little patient of the necessary amount of alcohol. She died on the third day of her sickness.

The day after the funeral the father of the children complained of severe headache, nausea, pain in the lower limbs, etc. On the left tonsil a small patch of diphtheritic exudation could be seen. He was at once placed on two drachm doses of the original prescription and ½ ounce of whisky 2 hours. The diphtheritic patch became loosened, and he seemed to improve nicely, when a few days after the first attack he was taken sick again and developed scarlet fever. The same treatment was continued, and patient made a good recovery.

A baby of four months had a slight attack of scarlet fever after all the others got well. She took 20 drops of the mixture every two hours, and soon recovered.

It would be interesting to report a larger number of cases, but space will not permit me to do so. If others give "the Brooklyn treatment" a fair trial, it would be desirable to have their experience published.—*Hospital Gazette.*

CHARACTERISTICS OF ANIMAL FIBERS.

ANIMAL fibers, unlike vegetable ones, do not burn in a continuous manner, but undergo a kind of fusion, giving off a nauseous odor similar to that of burned horn; at the same time a carbonized ball is formed at the end of the fiber or thread. Submitted to dry distillation, animal fibers give off products of a tarry composition much charged with carbonate of ammonia, a substance which is easily recognized by its smell and its alkaline reaction by bluing red litmus paper. Their composition is, on the whole, very uniform, and approaches much to that of gelatine and other albuminous substances, containing:

Carbon	50·65
Hydrogen	7·03
Azote	17·71
Oxygen and sulphur	24·61
	100·00

Wool, especially in the state in which it is employed, contains, according to Chevreul, a very notable proportion of sulphur, which amounts to 1·78 per cent. Its presence is manifested under many circumstances. Thus, by being simply exposed in a stove to a heat of 300° Fah., wool will give off a perceptible smell of sulphur. This smell is also noticeable when water containing wool is boiled. It is on account of this sulphur that wool gets black, especially, when heated, under the influence of certain metallic substances, such as acetate of lead, protochloride of tin, etc., and even when it comes in contact with metallic surfaces. Plunged into a boiling solution of nitrate of lead, wool becomes instantly black by being covered with sulphide of lead. These qualities are of great importance in the operation of dyeing. Alkalies may be employed to remove a great part of the sulphur in wool.

At the manufactory of Gobelins, in Paris, the hanks of wool are only immersed during 24 hours in a cold bath of milk of lime, after which they are washed in clean water, then in hydrochloric acid, and, finally, in water. Chevreul has, however, found that 28 immersions of 48 hours in lime water, and 28 passages through hydrochloric acid, are insufficient for removing all sulphur in wool; the fiber still retains about one-half per cent. of sulphur, though it does not darken any more with lead solutions.

Animal fibers are very sensitive to the action of fixed alkalies, especially when they are caustic, but the degree of concentration of these agents and their temperature have a great influence upon results. Thus, while wool bears without inconvenience light baths of carbonate of soda, it is immediately attacked by a lye of concentrated caustic soda when hot. Under these circumstances it is dissolved, and produces a soapy liquor, which is freely precipitated by acids.

It has been shown that concentrated sulphuric acid decomposes silk rapidly. It acts in the same manner upon wool and hair. Diluted with a little water it may give interesting effects. For instance, a piece of woolen tissue which has during a few moments been plunged into sulphuric acid of 55° suffers a considerable contraction, and is reduced in dimension in both directions; after this it is never attacked by insects.

Nitric acid makes wool and silk yellow by producing a yellow acid called "xanthoproteic;" this property has sometimes been used in dyeing, but such a proceeding is not to be recommended, because it always alters the chemical constitution of the fiber.

Animal fibers cannot be brought in contact with chlorine without, to some extent, being affected, but they resist the action of weak acids best of all. When animal fibers are plunged into the colorless solution obtained by boiling fuchsine with an alkali, and are then washed, they will be dyed red; well cleaned vegetable fibers have not this property.—*Textile Manufacturer.*

EXPERIMENTS ON THE FLOW OF SOLIDS.

THE following memorandum of the researches of Mons. Tresca is by Mr. Chandler Roberts, F.R.S., chemist to the Mint:

"The relation which the raised portions of the obverse of a coin should bear to those on the reverse, though of much importance, is often neglected by artists, and sometimes by skillful engravers, whose designs on separate dies are, in consequence, imperfectly represented or even distorted when the dies are employed simultaneously to produce impressions on the two sides of a metallic disk. As any theoretical facts which bear directly on this question must be of much practical value in coinage, I may perhaps be permitted to direct attention to some recent experiments by M. Tresca, sous-Directeur du Conservatoire des Arts et Métiers, of Paris, on the 'flow of solids.' He has shown that, when metals are submitted to compression, they so closely resemble fluids in their behavior, that the shape they will assume can be deduced by calculation. It is even possible to lay down the trajectory of the molecules of the compressed metal, and to establish with certainty the final places they will occupy, as compared with their initial positions; it follows, therefore, that the final position of any line or surface may be predicted.

"In stamping, the pressure is found to be gradually transmitted from one zone or layer of the blank to another, in absolutely the same manner as in the flow of liquids, and with a regularity not less remarkable, although following a much more rapid law of diminution. The engraved work on the die forms in fact a series of channels designed to facilitate the flow of the metal of which the coin or medal consists, and to guide it in the required directions. In the compression of a blank between dies, the portions not to be brought into relief by the action of the press are reduced in thickness for the benefit of the neighboring raised portions, the metal literally flowing radially from the level parts to the reliefs. This flow is, of course, gradual, and the presence of scars sometimes seen on medals in high relief may be traced to the junction, during the latter strokes of the press, of projections formed in the earlier stages. With such facts in view, M. Tresca has shown that it may sometimes be useful to distribute the flow of the metal by centripetal instead of vertical compression. It is to be hoped that these experiments will be continued, as the results appear to afford a scientific basis for an art which must always depend greatly on technical skill and individual experience."

ABSORPTION OF ULTRA-VIOLET RAYS BY THE ATMOSPHERE.

By A. CORNU.

THE author brings forward arguments, which, if not absolutely demonstrative, render it extremely probable that the real extent of the solar spectrum on the more refrangible side is considerable, and that it is abruptly cut off by the intervention of a foreign cause. This cause he shows experimentally to be atmospheric absorption. It remains to be ascertained what respective parts are played by the constituents of the atmosphere in this absorption.

PURIFICATION OF MERCURY.

By J. W. BRUHL.

THE mercury is shaken up with an equal volume of a solution of 5 grms. potassic bichromate in 1 liter water, with the addition of a few c.c. of sulphuric acid, the operation being continued till the water becomes of a pure green. A strong current of water is then introduced into the flask, which washes away a green powder. This process is repeated if needful, and the mercury is finally agitated with distilled water till its surface remains perfectly bright.

PRESERVATION OF WOOD BY CREOSOTE.

MR. JOHN BOGART, in his elaborate paper on the "Permanent Way of Railways in Great Britain, with especial reference to the Use of Timber Preserved and Unpreserved," has taken the trouble of collecting answers to a series of questions he circulated among the leading engineers of railways in Great Britain and Ireland.

The bulk of the sleepers used in English and Scotch railways are of Baltic red wood, generally about 9 ft. long, 10 in. by 5 in. in section. All the railway officials who have given answers, with one exception, record the process of creosoting as the method that has proved the most efficacious. Among the names of engineers who have supplied information, we find Mr. R. Johnson, of the Great Northern; Mr. E. H. Lloyd, of the Great Western, Mr. Alfred A. Langley, of the Great Eastern; Mr. W. Jacomb, of the London and South Western; Mr. H. Johnston, of the Midland, and several others. The process is the only one now in general use, and the amount of creosote oil forced into the wood averages 0·82 gallon per cubic foot, or the weight of oil forced in averages about 7·175 lb. per cubic foot. In many cases the work is done by contract, in others the company has its own creosoting works. The cost averages about 10d. a sleeper. As regards the average life of preserved sleepers, the answers are very various. Some give it as ten years, others twenty, but taking all the replies, sixteen years seems to be the general average, while the actual gain by the process is stated to be from two to ten years. In reply to the question whether preserved sleepers hold the spike better than unpreserved ones, the majority of answers goes to show that they do; though as far as compressibility is concerned, the experience of many is, that creosoting does not harden the wood so much as to prevent the chair cutting under heavy traffic. The writer mentions several samples of sleepers taken from roadways which are in an excellent state of preservation after a service of 10 to 22 years.

PREPARATION OF AMMONIA-FREE DISTILLED WATER.

By J. S. THOMSON.

THE method of water analysis, as elaborated by Messrs. Wanklyn and Chapman, leaves but little to be desired in the matter of simplicity. The only part of the process which is in any degree tedious is the preparation of the ammonia-free water. That such is the case, I think, is clearly shown by the number of suggestions which have from time to time been made with the object of either doing away with distillation in its preparation altogether, or of at least securing a larger proportion of the distillate fit for use in the process of analysis than is usually the case. These various processes, although no doubt very ingenious, have never come into general use, chemists still preferring to prepare the water by the original progress, tedious though it be. The process about to be described appears to be free from the objections commonly urged against the earlier ones, and at the same time it has the advantage that the original cost of the necessary apparatus is but small.

The following modification of the distilling apparatus commonly found in laboratories at once provides a simple means of securing a practically unlimited supply of ammonia-free water and at the same time demands little or no attention. The tube which conducts the water vapor from the still or boiler, in place of being connected directly with the worm or condenser pipe, is made to enter at the bottom of a large iron drum (say ten gallons), while the top of the drum is connected with the worm pipe in the ordinary manner. The drum, which is freely exposed to the atmosphere, condenses a portion of the aqueous vapor which, falling to the bottom, is kept in a state of ebullition by the free steam blowing through it. Now, if this be drawn off by a suitable tap it will be found to be perfectly free from ammonia, while the ordinary distilled water got at the worm end is teeming with ammonia. With apparatus of the dimensions given above, with a plentiful supply of steam, the ammonia-free water can be collected at the rate of about one gallon per hour.—*Chemical News.*

NICKELIZING WITHOUT ELECTRICITY.

ACCORDING to the *Moniteur Industriel*, so much of a salt of nickel is introduced into a 5 or 10 per cent. solution of zinc chloride till it assumes the ordinary color of a nickel bath. The articles to be coated, previously well cleaned, are laid in this solution, and the process is complete in from half an hour to an hour. Cobalt can be deposited in the same manner.